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The Engineer

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The Hamburg-American Liner Albert Ballin.

Shipping, Engineering and Machinery Exhibition at Olympia—No. IV.

Improved Thrust-boring Machine.

The British Association at Liverpool.

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Electricity in Mines—No. IX.

PUBLIC NOTICES

Tenders will be Received at the office of the Colonial Secretary in Singapore, S.S., on or before the 30th November, 1923 (due allowance being made for delays in the post), for the following WORKS :—

NEW GENERAL POST OFFICE, SINGAPORE.

Any person applying for a form of Tender must deposit the sum of £10 with the CROWN AGENTS FOR THE COLONIES, 4, Millbank, S.W. 1.

Drawings, specification, quantities and contract documents may be seen and forms of Tender obtained at the office of the Crown Agents between the hours of 10 a.m. and 4 p.m.

Tenders must be addressed to the COLONIAL SECRETARY, Straits Settlements, Singapore, to reach him by 30th November, 1923. The successful tenderer must undertake to find, if required, security to the amount of 100,000 dollars (Straits), which will be returned when the reserve deducted from certificates amounts to a like sum.

Tenders must be marked "Tender for New General Post Office, Singapore," and must be on the printed form issued by the Crown Agents.

In the event of any person whose Tender has been accepted failing within thirty days from the date of acceptance to enter into the necessary contract or deposit the security required under the contract for its due fulfilment, the sum deposited may be forfeited to the Crown.

Tenders sent to Singapore from overseas must be accompanied by the priced schedule of quantities, forwarded to the Colonial Secretary, Singapore, S.S., in separate sealed packets marked with the name and address of the tenderer. The priced schedule of quantities of the successful tenderer only will be opened for examination; in all other cases the schedules will be returned unopened.

The Government does not bind itself to accept the lowest or any Tender. 3527

Assistant Civil Engineers REQUIRED in Civil Engineer-in-Chief's Department, Admiralty, at H.M. Naval Establishments at home and abroad. Candidates must be corporate members of the Institution of Civil Engineers and not more than 30 years of age. Successful candidates will be on probation for two years, on satisfactory completion of which they will be appointed to the permanent staff, and will then be eligible for promotion to higher grades on the usual conditions.

Commencing salary £300 per annum; the current Civil Service bonus, at present about £100, will be paid in addition.

TEMPORARY ENGINEERING ASSISTANTS REQUIRED in London Office of Civil Engineer-in-Chief's Department, Admiralty, and at Outports. Candidates should have had a good general civil engineering experience and be capable draughtsmen, of between 24 and 28 years of age: if selected, they will be eligible, after one year's service—provided they are satisfactory and otherwise qualified—for the appointment of Assistant Civil Engineer on conditions mentioned above for that grade.

Commencing salary £150 per annum; the current Civil Service bonus, at present about £88, will be paid in addition.

In considering the limits of age some allowance will be made for war service.

No candidate will be accepted for an appointment who fails to pass a strict medical examination as to his physical fitness.

Forms of application can be obtained from Civil Engineer-in-Chief's Department, Admiralty, London, S.W. 1. Applications must be made on the recognised form and should reach the CIVIL ENGINEER-IN-CHIEF, Admiralty, not later than 6th October. 3548

Assistant Engineer Re- QUIRED by the GOVERNMENT of the GOLD COAST for the PUBLIC WORKS DEPARTMENT, for a tour of not less than 12 nor more than 18 months' service. Salary £480, rising to £720 a year by annual increments of £30, and thence to £820 a year by annual increments of £40. Outfit allowance of £60 on first appointment. Liberal leave in England on full salary. Free quarters and passages. Candidates, about 35 years of age, preferably single, must be qualified civil engineers, have had special experience in surface water and land drainage work and surveying.

Apply at once by letter, stating age, qualifications, whether married or single, and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/12,100. 3588

Resident Engineer Re- QUIRED by the KINGSTON (JAMAICA) GENERAL COMMISSIONERS for the HERMITAGE HYDRO-ELECTRIC SCHEME for three years, with possible extension. Salary £720 per annum, with free quarters and passage. Candidates, not over 40 years of age, should be qualified civil engineers with experience on construction of dams and water turbine installation, in dealing with contracts and contractors, and, if possible, some electrical and municipal experience.—Apply at once, in writing, giving brief details of qualifications and experience and stating age, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/11,854. 3587

NOW READY.

REPRINTS OF THE GENERAL DISCUSSION ON

Alloys Resistant to Corrosion, held in April, 1923 by the FARADAY SOCIETY and the SHEFFIELD SECTION of the INSTITUTE OF METALS.

Price in limp cloth cover 5s. 9d., including postage.

Among other Reports available are the following :—

	s.	d.
The Generation and Utilisation of Cold...	10	6
Catalysis, with Special Reference to Newer Theories of Chemical Action....	9	0
The Failure of Metals under Internal and Prolonged Stress. Bound in cloth	9	6
Bound in paper	7	0
Electro-deposition and Electro-plating	5	0

Orders should be sent to the FARADAY SOCIETY, 10, Essex-street, London, W.C. 2. 3566

PUBLIC NOTICES

The University of Sheffield.

SESSION 1923-24.

Vice-Chancellor: SIR HENRY HADOW, C.B.E., D.Mus., LL.D.

DEPARTMENTS OF MECHANICAL, ELECTRICAL, AND CIVIL ENGINEERING, METALLURGY, MINING, FUEL TECHNOLOGY, AND GLASS TECHNOLOGY.

The Courses in the DEPARTMENT of ENGINEERING extend over three or four years and prepare students to become Mechanical, Electrical, Civil or Mining Engineers, or specialists in Fuel Technology or Glass Technology.

The Courses in the DEPARTMENT of METALLURGY cover a period of three or four years and prepare students for positions of responsibility either (1) in Iron and Steel Manufacture, or 2) in the Non-ferrous Metallurgical Industries.

The LECTURE COURSES in all the Departments are supplemented by Practical Training in Laboratories and Workshops, which are fully equipped for the purpose of advanced scientific teaching, investigation and research.

Part-time Courses are arranged for students who desire to take special portions of any of the regular courses.

In Mining Engineering and in certain of the Courses in Mechanical and Electrical Engineering and in Glass Technology, arrangements are made to enable students, who come to the University from works or collieries, to take six months' courses of study at the University and six months' practice at the works or colliery each year for a period of four years.

The LECTURE COURSES commence OCTOBER 3rd, 1923.

The TECHNICAL LABORATORY COURSES commence SEPTEMBER 25th, 1923.

For further details of the Courses and for particulars of the Degrees, Associateships, Diplomas, and Certificates awarded on their successful completion, application should be made to

W. M. GIBBONS, Registrar.

3390

Technical College, Bradford.

DAY COURSES.

FULL-TIME (DAY) COURSES extending over three or four years, and leading to the Diploma of the College, are arranged in the following Departments :—

TEXTILE INDUSTRIES,
CHEMISTRY,
DYEING,
MECHANICAL ENGINEERING,
CIVIL ENGINEERING, ARCHITECTURE AND BUILDING,
ELECTRICAL ENGINEERING,
BIOLOGY.

These Courses are designed to meet the needs of Students wishing to present themselves for the Degree Examinations of the London University.

SPECIAL FACILITIES ARE AVAILABLE FOR ADVANCED STUDY AND RESEARCH.

Further particulars and prospectuses may be obtained on application to the PRINCIPAL, Technical College, Bradford. 3529

University of Birmingham.

CIVIL ENGINEERING DEPARTMENT.

Professor F. C. LEA, D.Sc., M. Inst. C.E., M.I. Mech. E., M.I. Met.

COURSES in CIVIL ENGINEERING, leading to the Degree of B.Sc. and Higher Degrees, also COURSES in CIVIC DESIGN and TOWN-PLANNING. The NEW SESSION will COMMENCE on OCTOBER 1st, 1923.

Full particulars and syllabus can be obtained from Professor Lea or from the undersigned.

GEO. H. MORLEY, Secretary.

3520

PUBLIC NOTICES

NORTHERN POLYTECHNIC INSTITUTE,

HOLLOWAY, LONDON, N.7.

DEPARTMENT OF ARCHITECTURE, SURVEYING AND BUILDING.

SPECIAL CLASSES IN STRUCTURAL ENGINEERING, REINFORCED CONCRETE AND GRAPHIC STATICS.

NEW SESSION COMMENCES TUESDAY, SEPTEMBER 25TH, 1923.

Fee for attendance three evenings per week, £1 10s.

3562

ENGINEERING AND TECHNICAL OPTICS.

Northampton Polytechnic Institute, ST. JOHN-STREET, LONDON, E.C. 1.

ENGINEERING DAY COLLEGE.

Full-time Day Courses in the Theory and Practice of Civil, Mechanical and Electrical Engineering. The Courses in Civil and Mechanical Engineering include specialisation in Automobile and Aeronautical Engineering, and those in Electrical Engineering include specialisation in Radio-telegraphy.

A SPECIAL ENTRANCE EXAMINATION is held at the end of September before the commencement of each session. The Courses include periods spent in commercial workshops and extend over four years. They also prepare for the Degree of B.Sc. in Engineering at the University of London. Fees £18 or £13 per annum.

THREE ENTRANCE SCHOLARSHIPS of the value of £62 each for the complete Course will be offered for competition at the annual entrance examination in September.

OPTICAL ENGINEERING AND TECHNICAL OPTICS.

Full and part-time Courses in this important Department of Applied Science are given in specially equipped laboratories and lecture rooms. The annual Entrance Examination is held at the end of September.

EVENING TECHNICAL COURSES

in all branches of Mechanical and Electrical Engineering commence on Monday, September 24th, 1923.

The Laboratories, both Mechanical and Electrical, are well equipped with modern apparatus which, on the mechanical side, provides for specialisation in Automobile and Aeronautical Engineering, and, on the electrical side, for specialisation in Alternate and Continuous-current Work, in Radio-telegraphy and Telephony, and in Electrical Testing.

More complete particulars, together with conditions of entrance, &c., and all information respecting the work of the Institute, can be obtained at the Institute or on application to

R. MULLINEUX WALMSLEY, D.Sc., Principal.

3453

PUBLIC NOTICES

County Borough of Wallasey.

FERRIES DEPARTMENT.

TENDERS are INVITED by the Ferries Committee for the SUPPLY of TWO MILD STEEL TAIL SHAFTS. Dimensions and details obtainable on application by letter to the office of the Ferries General Manager, Seacombe.

Tenders, on printed forms, which will be supplied on application, must reach me not later than Noon, 26th September, endorsed "Tenders for Shafting."

By Order,
GEO. LIVSEY, Town Clerk.

3561

Dominion of New Zealand.

18-MILE RAILWAY CONSTRUCTION TENDERS.

TENDERS CLOSE with the Public Works Tenders Board, Wellington, New Zealand, at Noon on 18th MARCH, 1924, for CONSTRUCTION of 18 MILES of RAILWAY, including BRIDGES, STATION BUILDINGS, EARTHWORKS, APPROACH ROAD METALLING, &c. Plans and specification may be inspected at the office of the HIGH COMMISSIONER FOR NEW ZEALAND, 415, Strand, London, W.C. 2. 3586

Ely Rural District Council.

WATER SUPPLY.

The Ely (Cambs.) Rural District Council invite TENDERS for the undermentioned WORKS :—

CONTRACT No. 1.—SUPPLYING and INSTALLING THREE-THROW RAM PUMPS, capacity 9000 gallons each per hour, and SEMI-DIESEL CRUDE OIL ENGINES.
CONTRACT No. 1a.—SINKING TWO 20in. BOREHOLES, 60ft. deep.
CONTRACT No. 2.—LAYING and JOINTING about 35 MILES of 7in., 3in., and 2in. MAINS.
CONTRACT No. 3.—CONSTRUCTION of TWO REINFORCED CONCRETE WATER TOWERS, capacity 100,000 gallons each.
CONTRACT No. 4.—SUPPLYING and DELIVERING approximately 2000 TONS of CAST IRON PIPES and SPECIALS.
CONTRACT No. 5.—SUPPLYING and DELIVERING CAST IRON VALVES and FITTINGS.

Plans may be seen and specifications, bills of quantities, and forms of Tender obtained at the Rural District Council Offices, 11, Lynn-road, Ely, Cambs., on application to the undersigned.

In respect of Contracts Nos. 2 and 3 a deposit of £5 will be required, which will be returned on receipt of bona fide Tender and the return of all documents supplied.

Sealed and endorsed Tenders, on the forms supplied, are to be delivered to the undersigned not later than 10 a.m. on the 10th October, 1923.

For the convenience of contractors the Engineer (Mr. L. E. Wilson, B.A., M. Inst. C.E., 43, Cavendish-avenue, Cambridge) will attend at the Rural District Council Offices, Ely, by appointment.

The Council do not bind themselves to accept the lowest or any Tender.

F. W. GREEN, Clerk to the Council.

Council Offices,
11, Lynn-road, Ely, Cambs.,
12th September, 1923. 3523

New Zealand East Coast Main TRUNK RAILWAY.

KATIKATI, AONGATETE, APARTA AND TE PUNA SECTIONS.

The Public Works Department, Wellington, N.Z., is inviting TENDERS for the CONSTRUCTION of the above SECTION of approximately 18 miles length.

A complete set of specifications, conditions of contract and drawings may be seen, by appointment, at the offices of THE BRITISH ENGINEERS' ASSOCIATION (Incorporated), 32, VICTORIA-STREET, LONDON, S.W. 1.

The work includes the complete construction of the railway, i.e., bush felling, clearing, construction of all earthworks, culverts, fencing, permanent way, station buildings, yards, bridges, &c. &c.

The closing date for acceptance of Tenders at Wellington, N.Z., is 18th March, 1924.

The date for completion of the work is three years from acceptance of Tender.

THE BRITISH ENGINEERS' ASSOCIATION (Incorporated),
32, VICTORIA-STREET,
LONDON, S.W. 1.

Telegrams, "Yimochi, Sowest, London."
Telephones, Victoria 1276, 1277, 9059. 3387

East Indian Railway.

The Directors are prepared to receive up to 11 a.m. on Wednesday, the 3rd October, proximo, TENDERS for the SUPPLY of :—

CROSSINGS AND SWITCHES.

Copies of the specification can be obtained at the Company's offices on payment of £1 1s. each. This fee will not be returned.

G. E. LILLIE, Secretary.

73-76, King William-street, London, E.C. 4.
20th September, 1923. 3605

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PUBLIC NOTICES

13th September, 1923.

Sudan Government Railways and Steamers REQUIRE the SERVICES of a MECHANICAL ENGINEER for the POST of ASSISTANT SUPERINTENDENT ENGINEER, Dockyard, Khartoum. Starting rate of pay £E480 per annum.

Age 26 to 32, preferably single. Applicants should have had thorough training in marine engineering and some dockyard experience, and must be good administrative men. Should possess A.M.I.C.E. degree or equivalent. Progressive and pensionable post if permanently retained.

Apply by letter, with copies of references, to CONSULTING MECHANICAL ENGINEER, Sudan Government Railways and Steamers, 5, Northumberland-avenue, W.C. 2. 3580

SITUATIONS OPEN

WANTED for Purchasing Dept., Chemical Works experienced ASSISTANT, familiar with Purchasing Engineering Equipment, Fittings, &c.—Address, stating age, experience, references, salary expected, 3602, The Engineer Office. 3602 A

WANTED for the Far East, an ASSISTANT, 30 to 35 years of age, for the Development of a Large Building Area, with architectural and building experience of "Type" Buildings. Three years' agreement and passage paid out and home.—Applications, by letter only, stating age, experience, and salary required, to be forwarded, together with copies of three testimonials, to W. J. PERKINS, A.M. Inst. C.E., M.I. Mech. E., Consulting Engineer, 26, Victoria-street, Westminster, London, S.W. 1. 3604 A

APPLICATIONS are INVITED for the POST of GENERAL MANAGER of Steam Wagon Works. Applicants must have the special engineering knowledge and trade experience required for this position, and must also have good organising ability both in regard to output and sales.—Apply by letter, stating age, experience, and salary required, to the SECRETARY, Yorkshire Patent Steam Wagon Co., c/o Clayton, Son and Co., Ltd., Moor End, Hunslet, Leeds. 3579 A

ASSISTANT SUPERINTENDENT REQUIRED for Large Machine Shop. Must be thoroughly experienced in this capacity and used to the production of highly finished work to close limits.—Address, giving age, full details of experience, with dates and names of previous employers, 3593, The Engineer Office. 3593 A

CAPABLE BOILER ENGINEER REQUIRED, to Take Charge of Tubular Boilers and Mechanical Stokers. Must be able to take CO2 readings and furnish detailed reports on plant.—Address, 3573, The Engineer Office. 3573 A

CONSTRUCTIONAL STEEL WORK DESIGNER.—London MAN REQUIRED at once, used to calculations and knows District Surveyors' requirements under 1909 Act for steel-frame buildings.—Write, giving experience, qualifications, and salary required, and when free. Also TWO DETAILING DRAUGHTSMEN for similar work, used to surveying jobs, preparing shop drawings on own responsibility from architects' drawings. Applications will not be considered from those not already having had experience or now in similar positions.—Write, "DRAUGHTSMAN," c/o W. Hay Fielding and Co., 43, Old Queen-street, Westminster, S.W. 1. P3037 A

ENGINEER REQUIRED as Assistant to General Manager of small Manufacturing Works in South-West England. Must have good technical training and knowledge of modern machining methods. Previous experience in the production of Compressed Air Tools an advantage, but not essential.—Apply by letter, with copies of testimonials, P3044, The Engineer Office. P3044 A

ENGINEER, Resident in or Near London, Having connection chemical and allied trade, also brewers, REQUIRED by well-known engineering concern. Applicant must have existing connection and be able to promote sales. Send full particulars of experience, qualifications, and references.—Address, P3042, The Engineer Office. P3042 A

ENGINEER, with Good Experience of Deep Well Pumps and Pumping Engines, to undertake all engineering and distribution duties, REQUIRED for a rural waterworks undertaking. Age over 30. Salary commencing £400 yearly.—Apply in writing, stating experience, T. and C. HAWKSLEY, 34, Old Queen-street, Westminster. 3584 A

LARGE COTTON MANUFACTURERS REQUIRE fully qualified MAN as PRINCIPAL ASSISTANT to the Chief Engineer having charge of all power and construction work at various mills. Applicants must have thorough experience in Steam and Electrical Power and Lighting as applied to textile factories and be capable of preparing plans and specifications on own account. State age, experience, and salary required.—Address, 3530, The Engineer Office. 3530 A

LONDON REPRESENTATIVE, with Engineering experience, WANTED by Largest Makers of Pumping Machinery in England. Must have first-class connection with export merchants, mining companies, and all industrial concerns in the London area. —Address, 3575, The Engineer Office. 3575 A

REQUIRED for India, MANAGER for General Engineering Works. Applicants must have held similar responsible position in British works and capable handling large staff, and should have good all-round general engineering knowledge, including constructional work and mining machinery. Also knowledge modern costing systems and commercial engineering. Three years' agreement. Salary Rs. 1200 monthly first year, Rs. 1300 second, Rs. 1400 third, also free house, light and coal.—Write, stating age, experience, and copy testimonials, to Box "P. G. A.," c/o Davies and Co., 95, Bishopsgate, E.C. 2. 3568 A

REQUIRED, YOUNG ENGINEER, Age About 23 or 24, at Depot abroad; good technical knowledge of engineering, combined with workshop experience, for period three years.—Write, stating age, experience, and salary required, enclosing references, to Z. R. 611, c/o Deacon's, Leadenhall-street, London. 2522 A

WORKS DIRECTOR WANTED for Large Engineering Establishment. Good education, wide experience of modern methods, knowledge of accurate work, exceptional organising ability, and knowledge of labour problems essential.—Address, 3560, The Engineer Office. 3560 A

WORKS MANAGER WANTED by Firm Engaged in the Manufacture of Colliery Machinery. Must have theoretical and practical knowledge. Commencing salary £600 per annum.—Address, 3594, The Engineer Office. 3594 A

WORKS MANAGER WANTED for Small Dublin Factory employing up to 150 hands on repair of Telephones and Telegraph Apparatus and Manufacture of small lines of Engineering Stores.—Address, stating salary required and giving age, nationality, experience, and qualifications, 3527, The Engineer Office. 3527 A

WANTED, First-class DRAUGHTSMAN. Accustomed to General Engineering Work. Must be well up in calculations. Please give full particulars of experience, age, and salary required.—Address, 3598, The Engineer Office. 3598 A

WANTED, LOCOMOTIVE DRAUGHTSMAN, to Prepare Designs and Specifications for Electric Locomotives. Must be a first-class man and have held a similar position. Applications, stating age, qualifications, and salary required.—Address, "LOCO.," Wm. Porteous and Co., Advertising Agents, Glasgow. P3045 A

LONDON COUNTY COUNCIL.

ENGINEERING

(AERONAUTICAL, CIVIL, ELECTRICAL, GAS, MARINE, MECHANICAL, MOTOR CAR, AND STRUCTURAL).

DAY AND EVENING CLASSES.

Battersea Polytechnic, Battersea Park Road, S.W. 11.	Full-time Day Courses in Mechanical Engineering, Civil and Constructional Engineering, and Electrical Engineering. Evening Classes in Mechanical, Civil, and Electrical Engineering. Trade Classes (including Classes for Motor Drivers).
Borough Polytechnic, Borough Road, S.E. 1.	Day Technical School for Boys intending to enter the Engineering Trades. Evening Classes in Mechanical Engineering (including Motor Car Engineering), Electrical Engineering. Trade Classes.
Finsbury Technical College, Leonard Street, City Road, E.C.	Full-time Day School only in Mechanical, Civil, and Electrical Engineering.
Goldsmiths' College, New Cross, S.E. 14.	Evening Classes in Electrical, Mechanical, and Constructional Engineering. Trade Classes.
Hackney Institute, Dalston Lane, E. 8.	Day Technical School of Engineering. Evening Classes in Electrical, Mechanical, Motor Car, and Structural Engineering.
Northampton Polytechnic, St. John Street, Clerkenwell, E.C. 1.	Civil, Mechanical (including Aeronautical), and Electrical Engineering. Full-time Day School and Evening Classes. Day and Evening Courses in Optical Engineering, and Part-time Courses for Apprentices in the Electrical Trades.
Paddington Technical Institute, Saltram Crescent, W. 9.	Day Technical School of Engineering. Evening Classes in Electrical and Mechanical Engineering.
Regent Street Polytechnic, Regent Street, W. 1.	Civil, Electrical, Motor Car, and Mechanical Engineering. Day School and Evening Classes. Evening Classes in Aeronautical and Gas Engineering.
School of Engineering and Navigation, High Street, Poplar, E. 14.	Day Technical School of Engineering. Evening Classes in Electrical, Marine, and Mechanical Engineering.
Wandsworth Technical Institute, High Street, Wandsworth, S.W. 18.	Evening Classes in Mechanical Engineering.
Westminster Technical Institute, Vincent Square, S.W. 1.	Evening Classes in Civil and Gas Engineering.
Woolwich Polytechnic, William Street, Woolwich, S.E. 18.	Day School for Boys intending to enter the Engineering Trades. Part-time Day Courses for Engineer and Trade Apprentices. Evening Classes in Mechanical, Structural, and Electrical Engineering. Surveying. Special Lectures in Motor Engineering. Trade Classes.

Full particulars as to fees, etc., may be obtained on application at the various Institutions.
Evening Classes open 17th September, 1923.
3519

JAMES BIRD,
Clerk of the London County Council.

SITUATIONS OPEN (continued)

DRAUGHTSMAN for Structural Engineering Office in London. Salary up to £5 per week.—Apply, stating age, experience, when free, to A. and J. MAIN and CO., Ltd., Australia House, Strand, W.C. 2. 3564 A

DRAUGHTSMAN REQUIRED for Engineering Firm in Bucks. Must be highly technical and experienced in the designing of all classes of Pumping Plants. Good prospects to right man. State age, experience, and salary.—Address, P3039, The Engineer Office. P3039 A

DRAUGHTSMAN REQUIRED; Must Have Had extensive experience in Light Railway, Wagons, Points and Crossings, &c.; able to take out material and make up estimates, and design any necessary tools for the manufacture of new types.—Address, giving full experience, age, salary required, 3595, The Engineer Office. 3595 A

DRAUGHTSMEN.—TWO REQUIRED by London Constructional Engineers; experienced designers essential. State experience, salary, enclosing copies of testimonials.—Address, P3048, The Engineer Office. P3048 A

DRAUGHTSMAN WANTED by Firm in N.W. London, with absolutely first-class mechanical knowledge. Some electrical experience would be of assistance. Good salary for the right man.—Address, stating age, salary, and experience, 3522, The Engineer Office. 3522 A

DRAUGHTSMAN WANTED, with Sound Experience in design of Steam and Power-driven Pumps.—Address, stating age, experience, and salary required, 3596, The Engineer Office. 3596 A

SCIENTIFICALLY TRAINED DRAUGHTSMAN, capable of carrying out Wind Channel Investigations and designing Equipment and Instruments in connection with same. Actual experience both in aeronautical drawing-office and in conducting wind channel tests essential.—Address, 3562, The Engineer Office. 3562 A

STRUCTURAL DRAUGHTSMAN REQUIRED in London. None but experienced men need apply. State full particulars, age, and salary required.—Address, 3601, The Engineer Office. 3601 A

FOREMAN PLATELAYER WANTED for Large Tramway System, South Africa; must be thoroughly experienced, able to take full charge on all systems of track work and methods of laying same; also roadways of granite, wood blocks, tar-macadam, Plasoum, and rail welding by electricity and Thermit, &c.—Address, stating age, full particulars experience, and salary required, 3585, The Engineer Office. 3585 A

WANTED, COST CLERK, Experienced in Modern methods and practice, to Take Full Charge of Costing in General and Repetition Ironfoundry in Cleveland district.—Write, stating age, experience, qualifications, and salary desired, to the SECRETARY, Pease and Partners, Ltd., Darlington. P3041 A

SITUATIONS WANTED

ADVERTISER, A.M.I. Mech. E., Shortly Disengaged, 20 years' experience in sawmill management at home and in the East, DESIRES suitable responsible APPOINTMENT either in similar capacity or in connection with the inspection and conversion of teak and valuable hardwoods. Thoroughly conversant with the design, erection, and running of modern plants for maximum economic output. Good organiser, office experience.—Address, P3013, The Engineer Office. P3013 B

SITUATIONS WANTED (continued)

A.M.I.C.E. (32), Apprenticed Crewe Works, with A. D.O., locomotive steam sheds, internal combustion, maintenance of plant, estimates and specifications, and commercial experience, wide technical knowledge, has had control of large staffs, not a specialist, DESIRES POST.—Address, P3054, The Engineer Office. P3054 B

APPOINTMENT DESIRED by Engineer, to Take Charge of Locomotives. Ten years in charge locomotive steam sheds and rolling stock; used to control. Highest references.—Address, P3049, The Engineer Office. P3049 B

COMPETENT, Widely Experienced MACHINERY DESIGNER (25 years' extensive experience) will Design throughout any Special Machine at client's works or own office on reasonable terms.—Address, P3035, The Engineer Office. P3035 B

DESIGNING DRAUGHTSMAN (38), Competent Man, shop trained, wholly experienced, DESIRES POST; specialist in new and original design, all classes machinery; temporary work accepted.—Address, P3036, The Engineer Office P3036 B

DIESEL and STEAM ENGINEER, Holder of Both Board of Trade First-class Certificates, SEEKS POSITION ashore. Has experience in repair shops, erection and running of heavy oil engines and oil fuel burning.—Address, P3056, The Engineer Office. P3056 B

ENGINEER (30), Sound Technical Training and good experience in all branches of engineering, steam, elec., gas and chem. plants construction and maintenance, R.I. con., designing, D.O., chemistry, surveying and fuels; used to control, good linguist, keen and hard working, DESIROUS POST.—Address, 3603, The Engineer Office. 3603 B

HYDRAULIC ENGINEER (39), Public School Man, holding responsible position on staff of large manufacturing concern, DESIRES CHANGE.—Address, P3051, The Engineer Office. P3051 B

MARINE ENGINEER, Age 35, DESIRES POSITION, home or abroad; 5 years chief engineer at sea, thorough practical experience all classes repair work.—Address, P3053, The Engineer Office. P3053 B

PRODUCER GAS TRACTION.—ADVERTISER, an experienced Works Manager and Research Engineer, SEEKS to get in TOUCH with FIRM interested in Gas Traction.—Address, P3047, The Engineer Office. P3047 B

RUSSIA.—BRITISH CIVIL ENGINEER, B.Sc. London, retired regular Army officer, at present engaged in structural steel in U.S.A., WISHES to get in TOUCH with FIRM doing CONSTRUCTION WORK in Russia. Sound knowledge of Russian language and people.—Address, 3545, The Engineer Office. 3545 B

TEMPORARY ASSISTANCE Given in Design, Construction, Surveying, Reporting, &c., by Civil Engineer with large varied experience. Specialty, waterworks and drainage.—Address, P3032, The Engineer Office. P3032 B

WILL YOU APPOINT, to That Vacancy in Works, D.O., or other important department, a man like a steel ball in a bearing, "similar to the rest," or one whose qualities are uncommon, who has ideas, originality, character, long experience? A reply to P3055, The Engineer Office, will reach a suitable candidate, an able MECHANICAL ENGINEER. P3055 B

DRAUGHTSMAN (Senior), DISENGAGED; Practical engineer, general engineering, designing with progressive and competitive ideas, electro, mechanical, detail.—Address, P3046, The Engineer Office. P3046 B

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For continuation of Small Advertisements see page 3

A Seven-Day Journal

Textile Machinery at the British Empire Exhibition.

THE general lay-out of the cotton textile industry section in the Palace of Industry at the British Empire Exhibition has now been definitely arranged by the committee responsible for this section. The exhibit will comprise raw cotton textile machinery and looms, the former to be supplied by members of the Textile Machinery Makers' Association, comprising, amongst other firms, Platt Bros., Asa Lees, Dobson and Barlow, Joseph Stubbs, Ashworths, Hetheringtons, and Arundel Coulthard. The looms will be supplied by members of the Loom Makers' Association, which comprises all the leading firms in this branch of engineering in Lancashire and Yorkshire. The arrangement of the plant will be such that the complete manufacture of cotton goods from the raw material to the finished product will be shown. A cinema is being provided in which a film will be displayed illustrating the processes of cotton manufacture in various countries. This film is being produced by the joint efforts of the Fine Spinners' Association, the Calico Printers' Association, and the Bleachers' Association. Yarns and fabrics will also form a special feature of the textile section.

A British Air Disaster.

ONE of the worst aeroplane accidents that have occurred since civil aviation began took place on Friday evening in England. The machine involved, a D.H. 34 eleven-seater belonging to the Daimler Hire, Limited, was on its regular journey from London to Manchester. The crash occurred near Ivinghoe, Buckinghamshire, fifteen minutes or so after the machine left Croydon. All on board, three passengers and two pilots, were instantly killed. It would appear that the pilot was attempting to make a forced landing at an unsuitable spot and that the descent ended in a nose-dive from a low height. It is impossible at present to suggest any reason why the pilot found it necessary to descend. The engine, it seems, was, so far as could be determined from the ground, running normally almost up to the last moment, and there were no signs that the machine was in difficulties other than the fact that it was flying low and apparently seeking to land. Just before the crash a loud report was heard. From these slender facts it is possible to build up many theories as to the cause of the disaster, but none seems satisfactorily to account for its mystery.

The Late Mr. J. B. Everard.

THE late Mr. John Breedon Everard, who died last week in his seventy-ninth year at Leicester, began his career in 1862, when he was articled to a firm of civil and mining engineers in South Yorkshire. In 1866, at the expiration of his indenture, he was appointed resident engineer on the Kentish Town-St. Pancras section of the Midland Railway, then in course of construction. Two years later he set up a practice as a civil engineer in Leicester and identified himself with questions of water supply. He was largely concerned with the initiation of the Derwent Valley water scheme, under which Leicester, Nottingham, Sheffield, Derby and Derbyshire draw their supply jointly from the river Derwent. To his care there fell the execution of the Leicester section of the scheme from Sawley to Hallgates, a section including an aqueduct across the Trent and two covered service reservoirs, each holding two million gallons of water. In addition to his work in connection with water supply, Mr. Everard identified himself with sewage disposal and quarry engineering and, through his firm, with architectural work. He was a member of the Civil Engineers, the Surveyors' Institute, the Geological Society, the British Architects and the Mining Institute.

Proposed New Bridge Across the Severn.

THE scheme for the construction of a new road and rail bridge across the Severn, referred to in the Journal for August 24th, was discussed at a conference of local authorities held at Chepstow on Saturday. It was unanimously decided that such a bridge was necessary and that the best site for it was between Beachley and Aust. As an outcome of the conference a deputation is to wait at an early date on the Great Western Railway authorities, the Ministry of Transport, and the Ministry of Labour, with a view to pressing forward the adoption of the scheme. The fact that the Severn Tunnel has reached the maximum point of its carrying capacity explains the interest of the Great Western Railway in the matter, but that company already has a scheme of its own for the construction of a four-rail bridge across the Severn, although for the time being that scheme appears to be in abeyance. Whether the company will consent to join forces in a proposal to construct a bridge that would provide accommodation for its own metals and for rival road traffic is not yet clear. Possible opposition may also come from those interested in the development of Sharpness as an outlet port for the canal traffic of the Midlands. It is definitely stated that from the railway company's standpoint any proposal to make the new bridge with a swinging or lifting section would prove a fatal objection to it, so that it seems virtually impossible to placate the interests both of the company and of Sharpness.

The Golders Green-Hendon Tube Extension.

IN order that the extension of the Golders Green tube railway to Hendon may be ready for opening next month efforts are being made all along the line to speed up the work. The spade work has been practically completed, and the engineers are proceeding quickly with the installation of the traffic equipment. The permanent way is being laid from both ends and the signalling equipment is in an advanced stage towards completion. The two new stations at Brent and Hendon are being carried out on novel architectural lines and the existing Golders Green Station is being remodelled to permit the operation of fifty-six trains per hour in both directions, as compared with thirty-six at the present moment. The company is taking all possible steps to preserve the natural beauty of the country through which the line passes. The embankments and cuttings are being sown with grass and at many points, it is contemplated, trees will be planted. In the design of the station buildings and of the bridges every care is being taken to make them of pleasant appearance.

The Proposed London-Liverpool Motor Way.

SPEAKING at Stoke-on-Trent a few days ago, Lord Montagu of Beaulieu, one of those interested in the scheme for constructing a high-speed private motor way from London to Manchester and Liverpool *vid* Birmingham and North Staffordshire, stated that the idea had been favourably received by many municipalities and industrialists. Of fifty-four public bodies with whom the promoters had communicated, fifty, he said, had resolved to support the scheme, two were neutral, and two had not replied. In their negotiations with the Government, he indicated, the promoters during the previous fortnight had made considerable progress, several of the Ministers having become greatly impressed by the scheme. It was now more likely than not that the Government would afford it considerable help. Lord Montagu added that he did not anticipate much opposition from the railways, and that landowners were already meeting the promoters in a reasonable spirit in the matter of the acquisition of the necessary land. It was hoped, he concluded, to concentrate this year on a road from Coventry to Salford, passing south of Birmingham and through the Potteries. This road would link up with the Manchester Ship Canal and would eventually be continued to Liverpool. The tremendous volume of heavy road traffic in that portion of the country rendered the construction of the road indicated a subject for primary consideration.

A Diesel Electric Ship.

AT the end of last week successful official trials were carried out on the La Playa, which has been built by Cammell Laird and Co., Limited, of Birkenhead, for the United Fruit Company, of Boston, U.S.A. This ship is the first of a series of three electrically propelled motor vessels which were ordered last year, her sister ships La Marea and La Perla being still on the stocks. The ships have been specially designed for carrying bananas in tropical climates. They have an overall length of 325ft., about 3800 tons gross tonnage and a sea speed of 14 knots. The propelling machinery comprises four generating units, each of which consists of a four-cylinder Camellaird-Fullagar Diesel engine running at 250 revolutions per minute and coupled directly to a direct-current 250-volt generator. The four generating units furnish the necessary power for the main propelling motor and are arranged so that they may be coupled in series, so that at full power four generators are used, while at reduced powers three, two or one may be used as desired. This arrangement of plant is stated to give economy in running, especially at low powers. The electrical propelling equipment has been supplied by the British Thomson-Houston Company, Limited, of Rugby, and the wiring, switchboard and the auxiliary motors by the Sunderland Forge Company, Limited. A feature of the trials was the smooth working of the machinery and the ease with which the designed speed of 14 knots was attained.

The Never-Stop Railway at Southend.

IN an article published in THE ENGINEER of July 27th we described and illustrated the remarkable Never-Stop train system, devised by Mr. Yorath Lewis, and erected in the Kursall Gardens at Southend-on-Sea. On Saturday last, the 15th inst., a demonstration of the system was arranged, which was attended by a large number of engineers. Captain H. Riall Sankey, in a short speech, paid a tribute to the skill and ingenuity of Mr. Yorath Lewis and his associate, Mr. Adkins, and to their untiring perseverance which had made the demonstration a success. Comparing the schedule speeds of various means of transportation, Captain Sankey said that electric trains had speeds of about 16 and 12 miles per hour when there were respectively two and three stations per mile. On the same basis the "Never-Stop" system could give 20 and 18 miles per hour, or 16 miles per hour with four stations per mile. It had also been calculated that the cost of the new system per seat mile would work out at much less than that of the electric train system. Personally, he had every belief in the success of the "Never-Stop" principle, and he felt sure that it would find a wide field of application both at home, in the Colonies, and abroad. The system would prove particularly useful for short railways—say, up to 5 miles—in congested districts and in many special instances, such as for mountain and cliff railways, and for piers and bridges.

An Improved Coking Plant.

CONSIDERABLE interest attaches to the new coking plant comprising sixty Wilputte ovens of the regenerative type, which has been put down by the Consett Iron Company, Limited. The output of the new ovens is expected to be at least 6000 tons per week, and with the Coppée by-product plant attached to the ovens, a large yield of by-products should be obtained. The installation practically "Americanises" the company's coke oven practice. Not only will the working temperatures be considerably higher than those in common practice, but the period of carbonisation will be reduced by nearly one-half. The success of the new plant is largely due to the initiative shown by Mr. Middleton, who is the manager of the coke ovens and the brickworks belonging to the company. After studying American practice and making his own experiments, Mr. Middleton decided that although there might be some small justification for the existing prejudice against silica bricks, it could be removed if the problem were tackled in the proper manner. For building the new ovens the company erected its own brickmaking plant, which has turned out all the silica bricks required.

Small Marine Motors.

IN a practical paper read before the Institution of Automobile Engineers at the Marine Conference, held at Olympia last week, Mr. Basil H. Joy dealt with some useful points in connection with the design of small engines. The main plea advanced by Mr. Joy was one for increased accessibility to all parts of the engine and its accessories. The cylinder heads should, he said, be detachable, and means should be provided for lifting and draining them, while overhead push rod valves were to be preferred to other types. The method of lifting the lubricating oil by the flywheel to an upper straining tank, and then feeding it by gravity to the working parts was recommended as being trustworthy, economical, and requiring no attention. We agree with the suggestion that crank case doors should be large enough to allow of the connecting rod big end being dismantled, and further that they should be attached to the crank case by dogs or wedges and not by a multiplicity of small nuts. The above are some of the outstanding suggestions in the paper. One more may be mentioned, for it is an original one, which, if put into practice, might have far-reaching effects. It is, that the designer should be compelled single handed to strip and re-erect, when actually installed in a boat, every engine designed by him, there being a proviso that where the weight becomes prohibitive, he shall be allowed unskilled labour for lifting purposes alone.

The Japanese Earthquake.

BY a strange coincidence we have accidentally discovered in this office a volume of photographic reproductions, illustrating the great earthquake in Japan in 1891, inscribed to the editor with the authors' compliments. The authors were—the late —Mr. John Milne, F.R.S., at that time Professor of Mining and Geology at the Imperial University of Japan, and Mr. W. K. Burton, Professor of Sanitary Engineering at the same institution. The severity of the 1891 earthquake was not so great as that which the country has just suffered, for although severe shocks were felt over an area of 4200 square miles, not more than about ten thousand people lost their lives, a number appalling enough, but less than a fifth apparently of the number of fatalities on the recent occasion. The book presents some extremely interesting pictures of the curious, not to say fantastic, results attending an earthquake, but it is in the introductory essay that chief scientific interest resides. Mr. Milne's hand is distinctly traceable in the writing of it. We find him speculating as to the cause of earthquakes, and telling us that he does not despair of one day being able to devise means of foretelling the time of their occurrence. Thirty-two years have since gone by, but although, largely as a consequence of Milne's work on the subject, seismology is in an advanced stage towards becoming an exact science—as witness the promptness and accuracy with which the occurrence of an earthquake is detected and located at a hundred different points on the globe's surface—the possibility of foretelling a visitation is still as remote from achievement as it was in 1891. Could that possibility be realised, there would open up a wide prospect for the saving of life in Japan and other countries subject to shocks.

H

Science and Industry in America.

By WALTER ROSENHAIN, D.Sc., F.R.S.

No. II.*

HAVING dealt with the more general aspects of the relation of science to industry in America, more detailed consideration may now be given to the applications of science and of scientific methods in some typical industrial and governmental establishments and to the work done in this connection in some American colleges and universities.

NON-FERROUS METALS.

Particularly favourable opportunities were accorded to the writer for studying the application of science and scientific methods to the industries concerned with the production and treatment of non-ferrous metals, particularly in the copper and brass industries, the aluminium industry and in the production of nickel and Monel metal. The same remark applies to tungsten, but since that metal is almost exclusively used and produced by the electrical industries, it will be more conveniently treated in that connection.

Dealing first with copper and brass, the use of scientific methods of control and investigation is now universally established; but this, it seems, is a comparatively recent development. It is stated to be one of the greatest achievements of Mr. Basset, the well-known chief metallurgist of the American Brass Company, now controlled by the Anaconda Copper Company, that by his personal and long-continued efforts he has introduced scientific methods into that group of industries. It must be borne in mind that the great brass industry which now flourishes in the Naugatuck Valley centred about Waterbury, Connecticut, has grown from small beginnings owing to the settlement in that locality of brassworkers who had emigrated from England. In these circumstances it was natural that the old rule-of-thumb methods should have grown up in this transplanted industry, the "art" being jealously guarded and passed on from father to son. Even now it is sometimes claimed, though not perhaps quite seriously, that brass cannot be made anywhere in America except in the Naugatuck Valley for lack of this inherited lore among the workmen. At the present time, however, scientific control has been carried to such a point that little dependence is or need be placed upon the personal knowledge of the workmen. Many of these about Waterbury come from the eastern parts of Europe and scarcely speak any English; they remain in America only long enough to acquire a competence, and, thanks to the very high wages paid in this industry, they are able to save their seven or eight thousand dollars in quite a small number of years and then return to their homes to live on the income derived from their savings. Such a condition does not, of course, favour the formation of any powerful trade unions among the workmen, and the industry, while paying very high wages, is thus free from restrictions of output or other factors hampering to the full development of automatic appliances and of scientific methods. Thus in the very numerous and highly developed automatic machine shops a single workman is able to take care of a whole row of machines. Apart from such machinery, however, which deals mainly with the manufacture of more or less finished products, carefully controlled methods are freely employed. Thus one type of brass tube is, in one of these works, annealed by the passage of an electric current through the tube itself. The tube is held at both ends by grips, which also constitute the electrical connections, and one end of the tube is so held as to be free to move longitudinally under the pull of a small weight. As the heating current raises the temperature of the tube the latter is not only softened, but thermally expanded, and the free end moves forward. The correct annealing temperature is determined by this thermal expansion; as soon as the tube has expanded longitudinally by the right amount the current is switched off and the tube detached, being allowed to roll away over guides to one side. Such a method of rapid annealing at an accurately regulated temperature would seem to be particularly applicable to low-temperature annealing, which has recently been shown to be efficient as a means of removing internal stresses without undue softening, but with a consequent elimination of the risk of "season cracking."

Other instances of a similar nature, involving the use both of actual scientific instruments or the application on a works scale of purely laboratory results, are fairly numerous. The pyrometric control of annealing operations in fairly large furnaces is widely used. This is regarded as particularly important in view of the high value attached to the question of "grain size" in brass. Specifications, including a definite requirement in regard to grain size, indicated either numerically in terms of the number of "grains" per unit area or by means of standard photo-micrographs, are very frequently employed, and the brass manufacturers find no particular difficulty in complying with such requirements. This is a striking contrast to the very great reluctance of British manufacturers and engineers to introduce micro-structure into specifications. American experience clearly indicates, however, that such a use of the micro-structure is perfectly simple and free from all serious ambiguity; there seems to be no difficulty in the interpretation of such clauses. On the other hand, it seems probable that inspection methods, both by the manufacturers themselves and by the inspectors of the purchasers, is less rigidly carried out in America; that is perhaps the real reason why American brass tubes do not always come up to such a standard as that set by British Admiralty requirements. Manufacturers, both here and in America, naturally seek to secure a minimum of rigidity in the enforcement of specifications; possibly in America their efforts in that direction are more successful than here. Such a state of affairs makes for large output, but in the end must be harmful to the industry, because it is harmful to the purchasers and leads to a relaxation in the standards of quality of the product. In these matters, however, there is a fundamental difference of attitude between British and Americans. The latter aim at producing something just "good enough" for its purpose, being content to see their products worn out and scrapped after a relatively short life, on the ground that something newer and better would in any case be desired long before an article "made to last" had worn out. This is plausible enough and, perhaps, sound in some instances. In others, however, it means really rapid deterioration of a new article; it begins to wear out so soon that its efficiency falls off too rapidly from the very beginning. The adoption of this attitude, however, is an important factor in making possible the enormous and cheap mass production on which the huge developments of American industry are based.

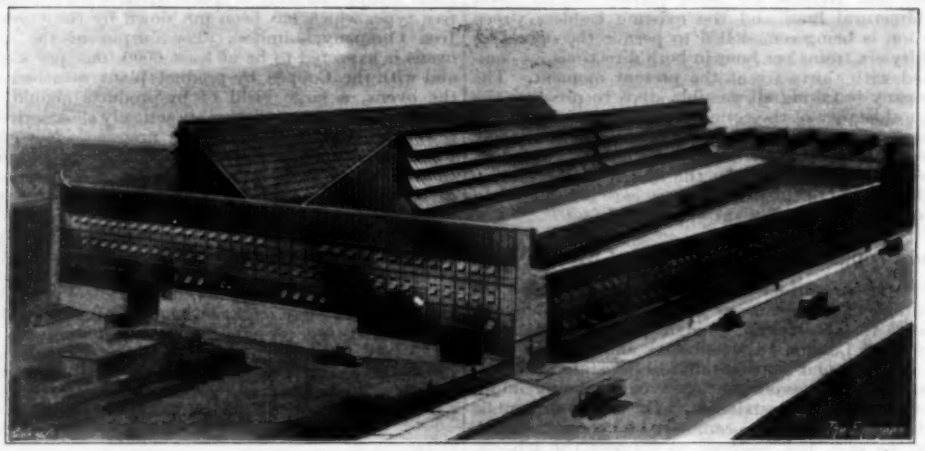


FIG. 1—BRIDGEPORT BRASS COMPANY—ELECTRIC CASTING SHOP

Another interesting feature of American brass works is the very extensive use which is made of the electric furnace in melting operations. In one works this has been carried so far that the new melting shop—Fig. 1—shows no chimneys, all the work being done electrically. This shop is very lofty and roomy and it has not been thought necessary to install any kind of special ventilating appliances for the removal of zinc oxide fumes. It is claimed that in the electric melting process very little zinc is lost and consequently but little fume is made, but the atmosphere of the interior of the shop was none the less somewhat dim.

The type of electric furnace used for melting ordinary brasses, ranging from 70 to 60 per cent. of copper, is almost exclusively that known as the "Ajax Wyatt." This is a furnace of the induction type, having a horizontal magnetic (iron) core, while the secondary circuit is formed of liquid metal and occupies a vertical position; it is, in fact, rather like a large wide crucible, through which the iron core, suitably insulated, passes near the bottom. There is thus a narrow channel of liquid metal around three sides of the "core" and a bath of metal of considerable size superposed on this. The metal in the narrow channel becomes strongly heated by induced current, and the combination of convection and "pinch effect" causes a rapid circulation of metal and consequent interchange of heat.† The furnace is not, of course, quite emptied when the charge is poured, thus leaving enough metal to form a circuit for commencing the melting of the next charge, an arrangement which requires continued working on the same alloy for as long a period as possible.

Curiously enough, this type of furnace, while it seems to be excellently suited for dealing with brass, cannot as yet be used with success on alloys richer in copper. This is variously ascribed to the higher electrical conductivity of the alloys richer in copper, to their higher melting point, and—probably the most serious point—to the fact that they rapidly attack the refractory walls of the narrow channel. If this is the case, it is a problem in refractories which a little research should readily overcome. Meanwhile a variety of other types of furnace, such as the "Detroit," which is simply an ordinary "barrel" furnace in which the usual oil or gas flame is replaced by the horizontal electric arc, are used for dealing with copper alloys other than brass. A certain number of pit fires are still in use in some of the brass works, although very great preference is now given to the electric furnace and its product. None the less, the use of the crucible gives facilities for the control of pouring conditions which do not seem to be so readily secured where the metal is poured direct into a group of moulds placed in front of the tilting type of electric furnace; where the best results are required there seem to be some objections to this method of direct pouring, possibly because it makes it more difficult to keep dross and other dirt out of the moulds while they are being filled.

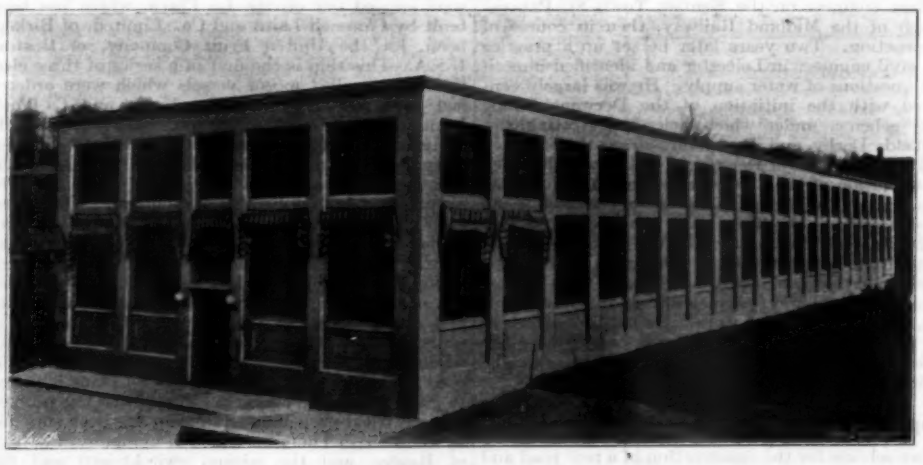


FIG. 2—SCOVILL MANUFACTURING COMPANY—CHEMISTRY AND TEST BUILDING

The high-frequency induction furnace, a type which offers such very tempting advantages from the theoretical point of view, does not as yet appear to have developed far beyond the laboratory stage. It is true that in one works a very special nickel alloy was being produced in a furnace of the "Ajax-Northrup" type, but only in very small quantities at a time—8 lb. to 10 lb. per heat. Two to three heats per hour were, however, possible, and a very

* No. I. appeared September 14th.

† See THE ENGINEER, January 14th, 1921, and August 5th, 1921.

remarkably pure product was being obtained. Furnaces of this type have been installed in a large number of American laboratories, and a few have also been exported to England. A few of these were seen at work and were spoken of with enthusiasm by their users; these being, however, some of the most expert scientific metallurgists. In a number of other laboratories, however, these outfits seemed to have succumbed to some of their infantile troubles. The general conclusion seems to be that the high-frequency induction furnace is a thing of the future, showing promise of exceptionally great value for a number of purposes. At present, however, the electrical equipment required to produce the high-frequency current is too elaborate, expensive and delicate for industrial use and even for many laboratories. It is to be hoped that these difficulties will soon be overcome, as the high-frequency type possesses many marked advantages; for laboratory purposes these are so great that the furnace will be widely used in spite of its present disadvantages; for industrial purposes much remains to be accomplished, except for very small-scale work. Efforts in that direction are being energetically made, and it may well be that in a few years time the high-frequency furnace—perhaps with the current generated by a combination of large triode tubes—will be available for the production of difficult and high-class alloys.

The laboratories attached to the great brass and copper works vary very widely in size and character. While they are all distinctly larger than those found in corresponding works in England, several of them are very reminiscent of our own—not too well laid out nor too well lighted. The most striking exception to this rule is the laboratory of the Scovill Manufacturing Company, at Waterbury, which is under the control of Mr. W. Price. The exterior appearance of this laboratory is shown in the illustration Fig. 2, which is reproduced from a publication of the Scovill Company. It is a long single-storey building of ferro-concrete, designed on factory lines, but fitted with a particularly well-arranged ventilating system. The interior is subdivided into a number of large rooms, devoted respectively to mechanical testing, chemical analysis, metallography, pyrometry and other scientific operations. The great bulk of the work done is of an essentially routine nature, dealing with the control of materials and products. A certain amount of research, however, is carried out, although this is aimed at direct practical results immediately required by manufacturing operations. Thus, extrusion has received much careful attention. Research of a more fundamental nature, aiming at future developments, is not, however, attempted.

The laboratories of the American Brass Company and of the Bridgeport Brass Company are on a decidedly smaller and less modern scale, but in the former an interesting development has been made in the application of the spectroscope to the chemical analysis of brass and other alloys. Messrs. Basset and Davis have published an interesting paper on this subject, which is also receiving special attention from Mr. Meggers at the Bureau of Standards at Washington. It is interesting to note that in both cases the Hilger quartz spectrograph is in use, this being one of the very few examples of scientific instruments of British make being used in American laboratories. The regular use of spectroscopic methods in the analysis of alloys by the American Brass Company is in itself evidence of the value of the method. This appears to lie mainly in the speed with which the nature of an alloy can be ascertained and the accuracy—said to be greater than that obtainable by ordinary methods of chemical analysis—with which impurities present in minute amounts can be quantitatively determined. Specifications for high-grade brass sometimes demand that bismuth and antimony shall not be present to an extent exceeding 0.001 per cent. or even less. This presents a difficult problem to the analyst, particularly since antimony may, in some cases, be derived in small quantities from the glass vessels in which the analysis must be carried out. But even the primary constituents of an alloy can be rapidly and accurately ascertained by comparing the photographs of the spectra of the alloy with standards previously prepared or taken at the same time from known materials. One very great value of the method lies in the fact that if a batch of metal shows abnormal behaviour and yet is declared to be "exactly the same as always," a rapid comparison of the spectra will at once indicate whether any serious abnormality of composition or some unexpected impurity has crept in. Here the spectroscopic method has a great advantage over that of the chemical analyst, since the latter as a rule must look specifically for each constituent or impurity which is to be determined.

In the metallographic laboratories of the brass and copper works little more than routine work seemed to be undertaken, and this exclusively by means of the "inverted" type of metallurgical microscope of the type originated by Le Chatelier and exploited in recent years mainly by German manufacturers, although a certain number of instruments of this type made in America are also in use. It is an interesting indication of the very great influence which German science has had on America that this type of instrument is universally used for metallographic purposes throughout America in all branches of metallurgical work. There seems little room for doubt that this devotion to the "inverted" type, which is essentially designed for photographic purposes, is a mistake. It is certainly an easy instrument to use where a large number of photographs have to be produced without much careful preliminary visual examination of the sections. Actually, these instruments are very uncomfortable when used for visual examination. Yet searching preliminary visual study of a section is really essential if a truly typical photo-micrograph is to be prepared. Two sections from different pieces of metal may, at first sight, look almost exactly alike, and photographs taken without further thought would appear equally similar. Yet it may be that a little further examination would show that in one of the sections, perhaps more or less masked to casual inspection, but clear enough on prolonged and careful study, there is some important feature which affords a clue to the solution of a difficulty or accounts for some unusual behaviour. With the "inverted" microscope such somewhat subtle differences are almost certain to be missed; an observer must be able to sit in a comfortable position and have the eye-piece before him at a comfortable angle which does not tire the eyes if he is to make a careful study of his sections. If he photographs them and relies upon a comparison of the photographs, it is rather like a detective merely taking a photograph of the scene of a crime without first making a careful examination in order to see something more than the general features of the scene. The ordinary type of inclined limb microscope, which we may perhaps term the "English" type, is far more adapted to careful searching study of metal sections, and is—in the last resort—capable of producing finer photo-micrographs also. English metallurgical microscopes, however, appear to be almost unknown in America.

COPPER REFINING.

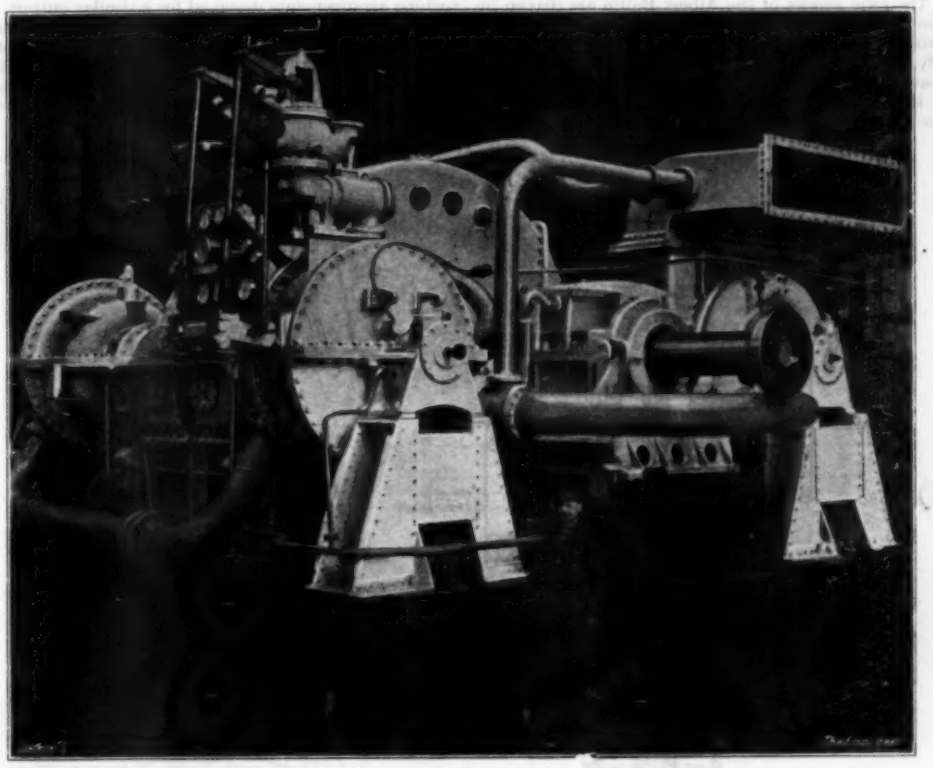
Although from the standpoint of the physical metallurgist the production and treatment of alloys is perhaps of greater interest than the refining of a pure metal, no account of American non-ferrous metallurgy and its relation to science could omit mention of the great plants engaged in the extraction and refining of copper. The reduction plants in which the crude copper is obtained from the ores are situated in the mining districts which, for geographical reasons, the writer was unable to visit. The great Raritan Copper Works of the Anaconda Company, however, are situated at Perth Amboy, only a short distance from New York, and these works the writer had an opportunity of inspecting, at the invitation of the company and under the guidance of their expert metallurgist, Dr. Skowronsky. The most impressive feature of these works is the enormous scale upon which the operations are carried out. Thus the furnaces in which the refined copper is melted, "flapped" and "poled" for the production of ingots, slabs and wire bars, contain 300 tons of molten copper, and this metal is "teemed" or run direct into moulds placed on a great rotating casting table in a fashion which recalls steel works practice rather than that of non-ferrous establishments. Photographs of such a table and of one of these great furnaces, kindly supplied by the company, are reproduced on page 312.

The refining of copper at Raritan is done by the electrolytic process, which is carried out in great assemblies of vats placed in wide well-lighted and well-ventilated halls. Work of this kind, to be efficient, demands most careful scientific control, and this is afforded by a well-equipped laboratory in which a large amount of routine control work is carried out. An important feature of the work is the control of the by-product recovery, which has assumed very great importance, these "by-products" including selenium and tellurium, silver, gold and platinum metals, all these being recovered systematically and very efficiently from the slime found at the bottom of the electrolytic refining vats. The work of the Raritan laboratory, however, goes a good deal further than routine control, and Dr. Skowronsky has carried out a number of series of investigations on the effects of various impurities on copper, notably in regard to sulphur and iron.

While thus fully recognising what has been achieved at Raritan, the same remarks apply here as in most other non-ferrous establishments in America—research on more fundamental matters affecting the industry, but requiring a "long view" because no immediate results can be foreseen, is not attempted. In an industry which has assumed these immense proportions one might have hoped that something in that direction might be attempted, if only because in the long run, when conditions become more difficult, as they are bound to do in the future, the fundamental knowledge derived from research work of this wider scope is bound to prove of the greatest value; indeed, the very maintenance of the industry on a large scale may ultimately become dependent upon research discoveries affecting new processes of production or new uses and markets for the product.

STARBOARD TURBINE UNIT OF THE ALBERT BALLIN

BLOHM AND VOSS, HAMBURG, ENGINEERS



The Hamburg-American Liner Albert Ballin.

No. II.*

THE propelling machinery of the Albert Ballin, which we describe and illustrate in the present article, was built by Blohm and Voss, of Hamburg, and represents the most recent practice of the firm with regard to geared turbine installations of the single reduction type. Prior to the war, among the largest turbines built by Blohm and Voss, were those for the German battle-cruisers, Von der Tann and Goeben, as well as the two largest Hamburg-American liners, the Vaterland and the Bismarck, which have since passed into American and British ownership. Since 1919, however, the experimental work of the firm and progress in design has been chiefly directed towards developing a system of geared turbines for

* No. I. appeared September 14th.

steamships and a combination of Diesel engines and gearing for motor ships, which give, it is claimed, reduced space and weight, with increased efficiency of propulsion.

THE ARRANGEMENT OF TURBINE MACHINERY.

The twin screws of the Albert Ballin are driven by two turbine units of equal size and output, which are quite independent of each other, but are symmetrically arranged in a common engine-room. The drawing we reproduce in Fig. 8 shows the plan view of the starboard unit which, along with Fig. 10 and the illustration on p. 299, serves to indicate the main points of the design. It will be seen that the set is so divided that when running ahead four turbine stages are used, while when going astern two stages only are in operation, the astern wheels being incorporated in the high-pressure and low-pressure casings of the ahead turbines. The main gear wheel is placed centrally to the four turbines, and is driven by two pinion shafts. Thus the outer pinion is driven at its after end by the high-pressure turbine and at its forward end by the first intermediate pressure turbine, while the inner pinion derives its motion at the forward end from the second intermediate pressure turbine and at the after end from the low-pressure turbine. The builders claim that on this system each pinion is subjected to equal torsion from either side, so that twisting is prevented, and that the teeth are loaded equally as regards pressure throughout their entire length. Axial thrust is also eliminated, and no thrust bearings are required. Furthermore, as right and left-hand cut pinions are employed on the same shaft they are, it is claimed, practically self-aligning. Another advantage of the divided turbine arrangement is that the size of parts and the heat stresses are reduced to a minimum, while owing to the smaller size of flanges, dummy rings and stuffing-boxes, they can readily be kept tight, with increased reliability in running. Finally the arrangement is such as to give complete access to all parts of the plant, thereby facilitating easy examination and overhaul. We understand that the overall steam efficiency of the machinery is good, and that its weight compares favourably with that of other turbine arrangements designed for a similar output.

It may be noted that the high-pressure turbine and the first intermediate stage turbine have both impulse and reaction blading, while the second intermediate pressure turbine and the low-pressure turbine, are of the pure reaction type. Both astern turbines have impulse wheels with two rows of blading. Each unit as shown is designed to develop 6000 horse-power, at a speed of 2100 revolutions per minute, giving a combined total horse-power of 12,000. The ratio of the gearing is 20 : 1, the speed of the propellers being about 110 revolutions per minute, corresponding to a designed sea speed of the vessel of 16 knots. Two pinions of equal size engage with the large centre wheel, to which the tail shaft and propeller tunnel shafting are coupled. The propeller thrust is taken up by a Michell thrust block placed on a strong and well braced foundation. The block is of the single thrust ring type, and the movable pads, ten for ahead and ten for astern, are each capable of individual adjustment. The tunnel shafting is supported in sixteen bearings fitted with automatic lubrication. Built-up propellers having a diameter of 17ft. and a pitch of the same dimension, are employed, each propeller having four blades and a cast iron boss furnished with steel junk rings. The stern tubes are lined in the usual manner with lignum-vitæ bushes.

Reference may be made to the lubricating system to which special attention has been given. A duplex steam pump supplies oil through a strainer to an overhead tank, from which it is distributed to all oil feeds and flows back to a tank arranged in the double bottom of the ship. By this means all the bearings on the turbine, gearing, and thrust block are supplied with oil at constant and uniform pressure. In the gear-box oil is distributed to the wheel teeth by jets in the ordinary manner. Control valves are so arranged that both the flow of oil and its temperature are under permanent control. In Fig 6 we show an automatic shut-off valve which is designed to allow steam to pass only when the full oil pressure has been reached. It is designed as a double beat valve, closed by a spring and counterbalanced by a piston, which is moved by the pressure in the oil supply pipe. Should the pressure at any time fall below a fixed limit, the spring closes the valve and shuts off steam from the turbines. In a similar way, the bursting of a blade wheel, such as might conceivably take place in the case of a fractured gear pinion is guarded against by an emergency governor placed at the end of each turbine shaft. The governor is designed to come into action immediately a certain number of revolutions has been reached.

We may briefly refer to the labyrinth packings at the turbine ends, which are composed of dummy rings of soft metal, fastened in the stuffing-box gland and on the turbine spindle. As when going ahead and astern these stuffing-boxes must be tight both against steam pressure and vacuum, arrangements are made whereby in the first case any escaping steam is led to the condenser, and in the second case all leakages are prevented by admitting gland steam at a reduced pressure.

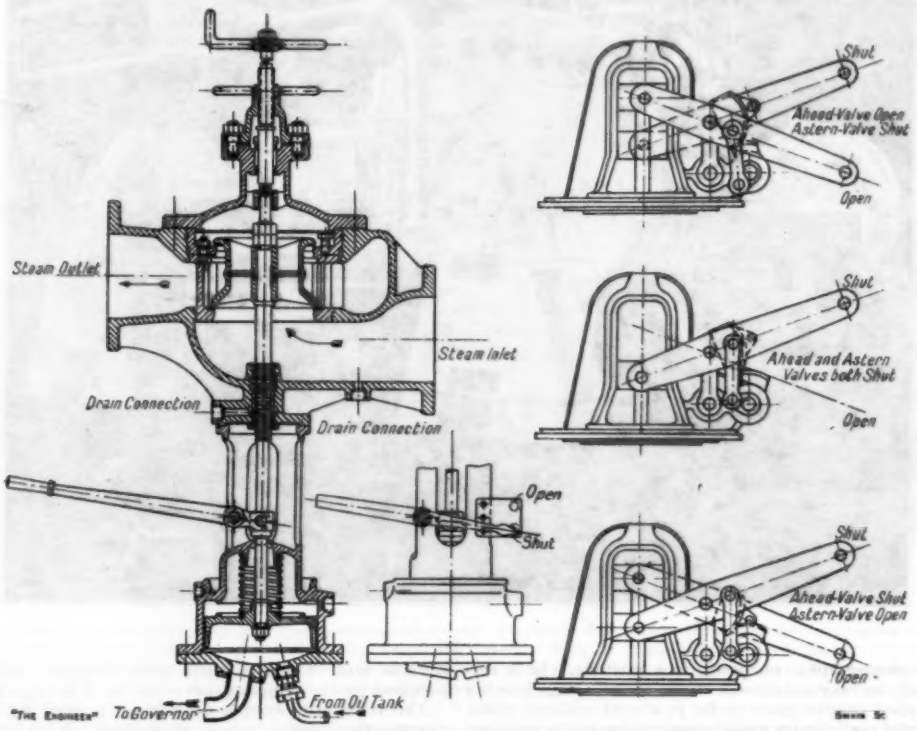


FIG. 6—AUTOMATIC SHUT-OFF VALVE AND MAIN CONTROL LOCKING DEVICE

TURBINE CONTROL AND ENGINE-ROOM AUXILIARIES.

Each turbine unit is controlled by two main hand wheels, behind which steam gauges, revolution counter, &c.—as shown in Fig. 9—are grouped on a board This illustration also serves to show the type of control valve used, while the three figures on the right of Fig. 6 indicate the locking arrangements with the control gear in various positions. Above the turbines and gear casings there is a system of overhead runways and pulley blocks, which allows of easy and accurate lifting and dismantling of casings and drums. With a view to obtaining short pipe lengths and a clear arrangement of auxiliaries, the pumps and the other engine-room auxiliary machinery are divided into the following groups :—

(1) Condensing plant. Air pumps beneath condensers and circulating pumps at the aft bulkhead of the engine-room.

(2) Boiler feed plant at the forward engine-room bulkhead between the main turbines and the boiler-room.

(3) Service pumps and other apparatus on either side of the engine-room.

(4) Refrigerating plant at the forward end of the tunnel adjoining the refrigerating rooms.

(5) Appliances for oil fuel service at the forward boiler-room bulkhead.

(6) Electrical plant above the condensers.

(7) Tanks, distribution and valve-boxes, branches, &c., in the engine-room hatch and in the dummy funnel.

The main condensers are fixed athwartships aft and are supported beneath by a pillar and a bracket fixed to the engine-room bulkhead. Each condenser has a surface of 600 square metres and brass tubes are fitted having an external diameter of 19 mm. and a thickness of 1.5 mm. The upper rows are composed of tubes 2.0 mm. in thickness. Two steam engine-driven circulating water pumps having a capacity of 2400 tons of water per hour when running at a speed of 250 revolutions per minute are used. The inlet sea valve is placed close to the pump and the water enters the condenser at the top. Below each condenser the air pumps and condensate pumps are fixed. Steam ejector air pumps of the Balcke-Leblanc type are used, two ejectors being supplied

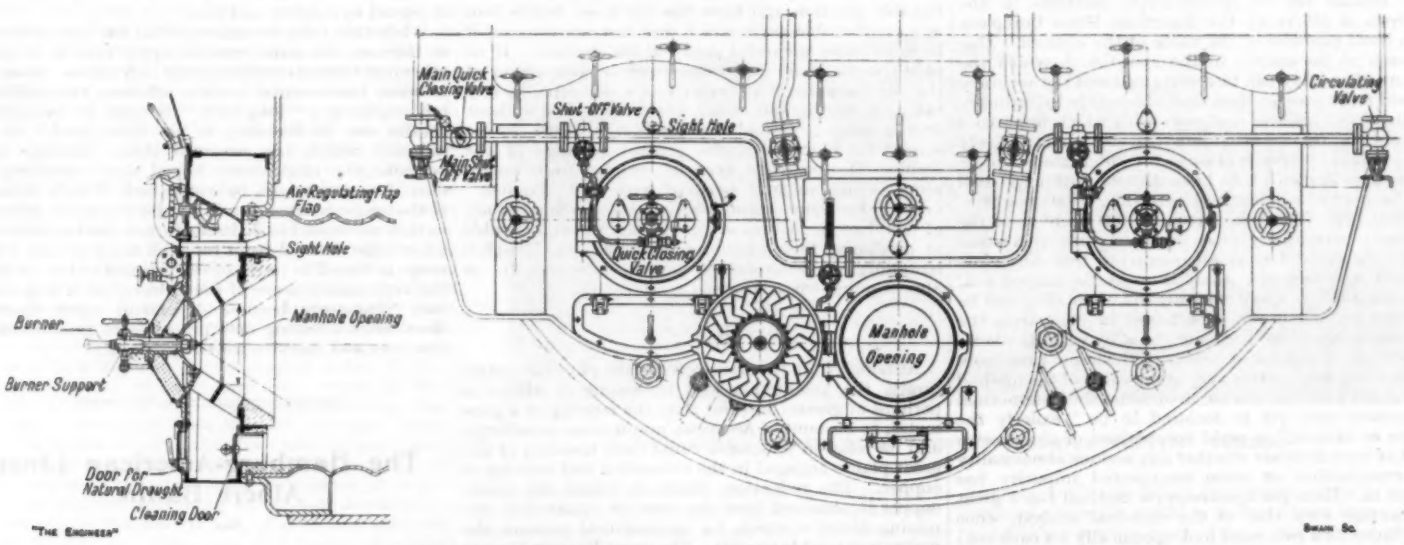


FIG. 7—BLOHM AND VOSS OIL FIRING SYSTEM FOR MARINE BOILERS

MACHINERY OF THE LINER ALBERT BALLIN

BLOHM AND VOSS, HAMBURG, ENGINEERS

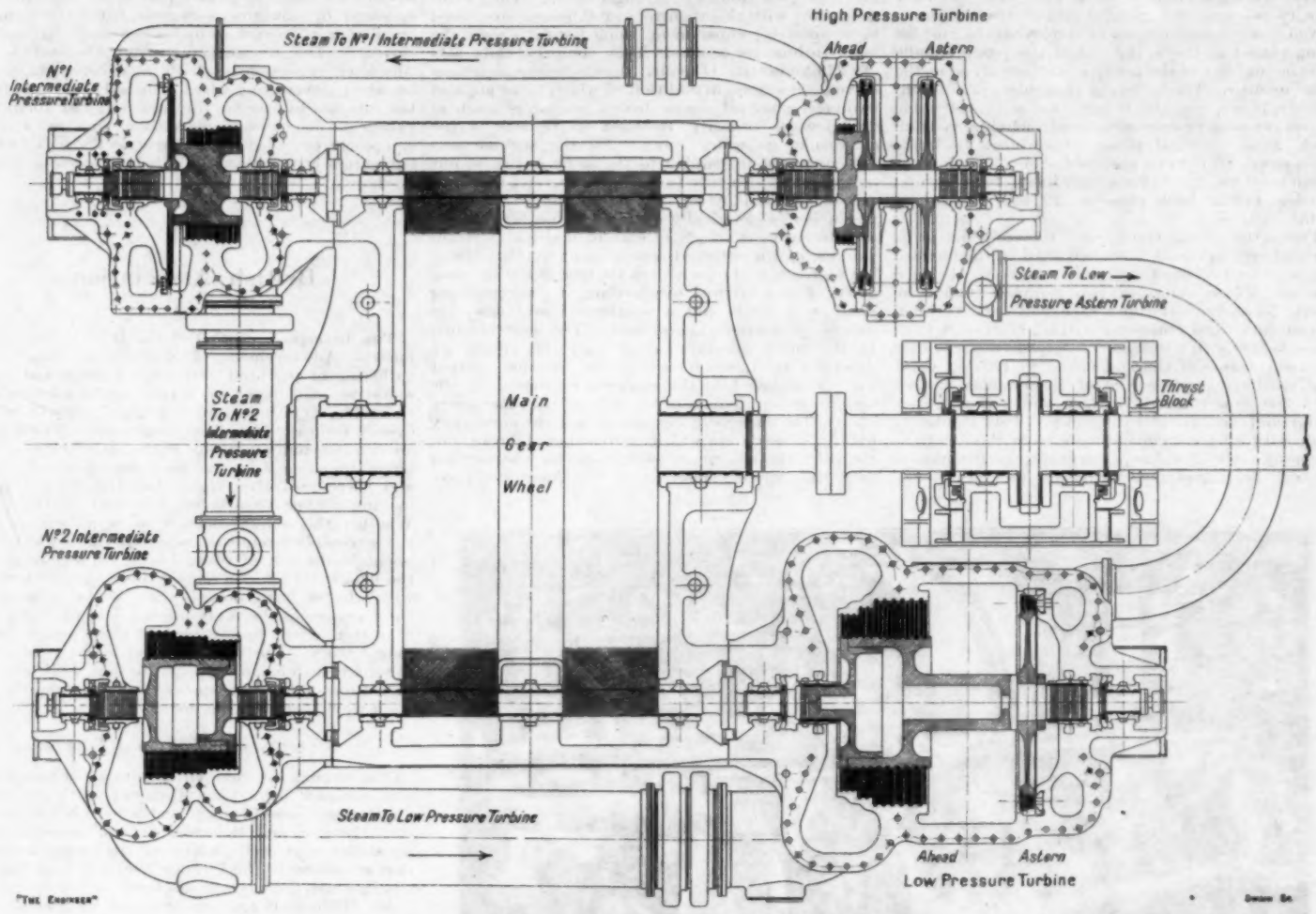


FIG. 8—PLAN OF STARBOARD TURBINE AND GEARING UNIT

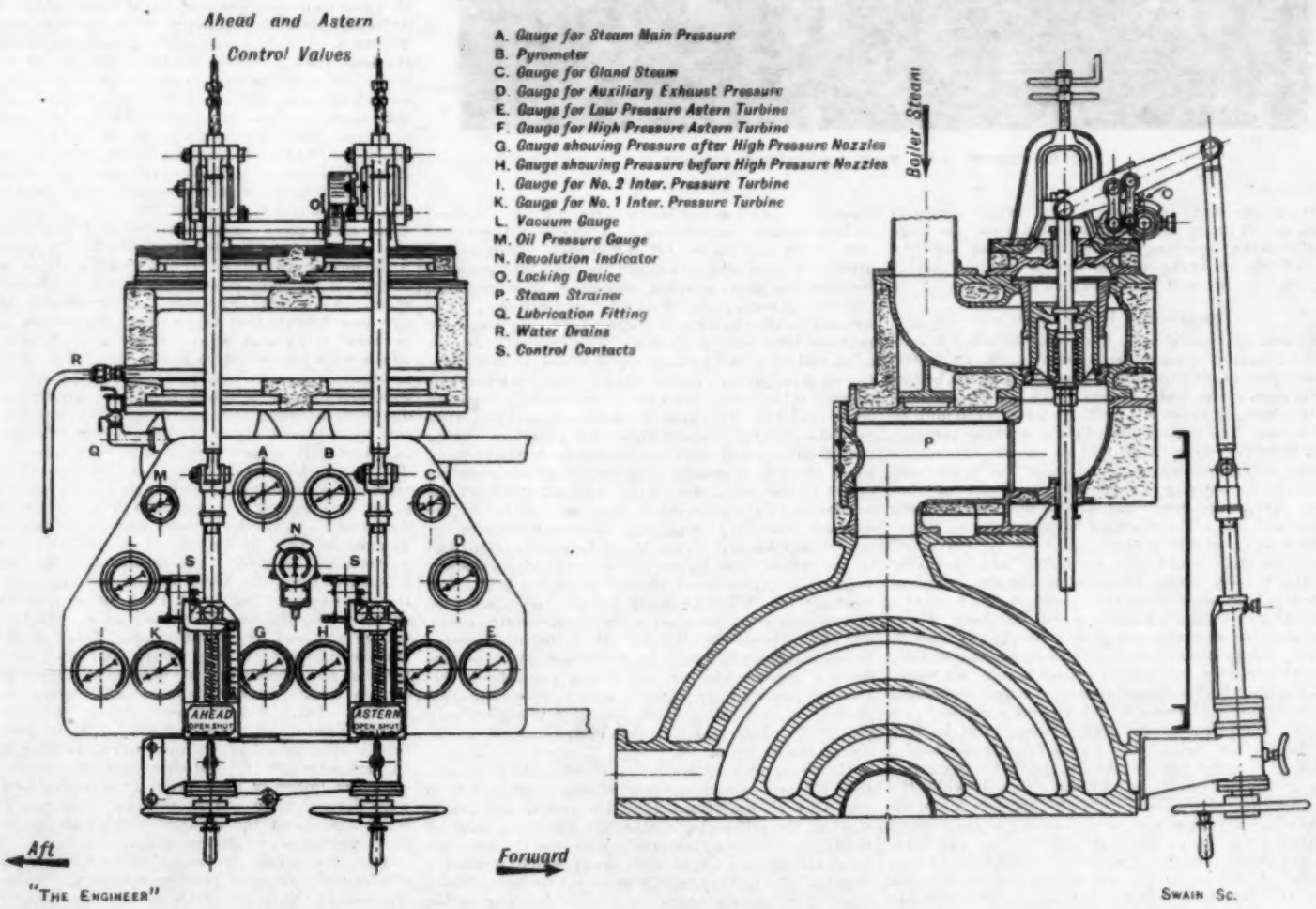

Ahead and Astern Control Valves
A. Gauge for Steam Main Pressure
B. Pyrometer
C. Gauge for Gland Steam
D. Gauge for Auxiliary Exhaust Pressure
E. Gauge for Low Pressure Astern Turbine
F. Gauge for High Pressure Astern Turbine
G. Gauge showing Pressure after High Pressure Nozzles
H. Gauge showing Pressure before High Pressure Nozzles
I. Gauge for No. 2 Inter. Pressure Turbine
K. Gauge for No. 1 Inter. Pressure Turbine
L. Vacuum Gauge
M. Oil Pressure Gauge
N. Revolution Indicator
O. Locking Device
P. Steam Strainer
Q. Lubrication Fitting
R. Water Drains
S. Control Contacts
Boiler Steam
AHEAD
ASTERN
Aft
Forward
"THE ENGINEER"
SWAIN SC.

FIG. 9—CONTROL VALVES AND GAUGE BOARD AND SECTION THROUGH AHEAD CONTROL VALVE

for each condenser. The main ejector requires 620 kilos. of operating steam per hour and the second one is rated at 310 kilos. per hour. Both pumps are fastened to the intermediate condenser and they are arranged for a normal working pressure of about 118 lb. per square inch steam pressure. The larger ejector is designed to draw off 47 kilos. of air per hour at a 95 per cent. vacuum. Vertical steam turbine-driven condensate pumps are employed, the turbine being placed at the upper end of the pump spindle and the impeller of the pump at the lower end in the usual manner. The following particulars of the condensate pump may be noted. Capacity, 64 cubic metres per hour ; manometric head, including vacuum l.-ad, 23 m.; normal power of turbine, 13 brake horse-power ; power absorbed, 11 horse-power ; steam pressure, 220 lb. per square inch ; temperature, 250 deg. Cent.; back pressure, 29.4 lb. per square inch.

From the main condensers the condensate is pumped into an elevated hotwell fixed on the forward engine-room bulkhead, whence it flows to the feed pumps. These comprise two Simplex pumps by Georg Niemeyer, Harburg-Elbe and two turbine-driven centrifugal pumps by A.E.G., Berlin. A feed-water heater with a surface of 70 square metres raises the temperature of the boiler feed to 120 deg. Cent. The auxiliary condenser is of the circular pattern with 300 square metres surface and a Simplex air pump and one circulating pump. This condenser deals with all the exhaust steam from the auxiliary engines, turbo-dynamos, refrigerating machinery, winches, heating piping, and galley apparatus. The refrigerating plant is installed in a special compartment aft of the engine-room and comprises one large double-acting machine having a designed capacity of 200,000 kilogram-calories and a smaller one of 17,500, together with the necessary auxiliaries.

The Boiler Installation.

Four single-ended and four double-ended Scotch boilers, having a combined heating surface of 3000 square metres, are installed. The single-ended boilers have each three and the double-ended six furnaces of the Morison type with a diameter of 1150 mm. to 1250 mm. They are designed for a working pressure of 220 lb. per square inch and are fitted with return smoke tube superheaters which raise the steam temperature to 350 deg. Cent. All the boiler uptakes join together in one funnel, the second funnel being a dummy one. The drawing we reproduce in Fig. 7 serves to show the Blohm and Voss system of oil firing with which all boilers are fitted. Oil is supplied to the burners under pressure at a temperature of 120 deg. Cent. and enters the furnace in the form of a conical spray. Each burner, it will be noted, is surrounded by a double ring of guide blades, which direct the incoming air from the fans tangentially into the oil cone, so causing a quickly rotating flame. This action, it is claimed, results in a perfect mixing of the oxygen of the air with the oil particles, producing complete combustion without local heating of the furnace tube. The two sets of guide blades referred to are of different design, the first ring guiding the air to the outer zone of the oil cone, while the second ring of blades directs the air nearer to the axis of the oil cone, and prevents even at the highest burner capacity, namely, 240 kilos. of oil per hour, any unburnt particles of oil from reaching the furnace walls. Access to the furnace is obtained by swinging out the first set of guide blades, as illustrated in Fig. 7. In order to prevent unequal heating or cooling of the furnace, interior furnace brickwork is entirely dispensed with.

The Electrical Plant.

In conclusion, brief reference may be made to the electrical equipment of the ship, the generating plant and the distribution arrangements. The main generators with their control switchboards are placed in a special compartment immediately above the main turbine condensers. They comprise three sets of 220-kilowatt, 115-volt, direct-current turbine-driven generators, in addition to which there are also two emergency oil engine-driven generators, each of 25 kilowatts capacity, installed on D deck in the emergency generator room. All the turbine sets are connected in parallel to the same bus-bars, but in general service only two are running and the third acts as the standby set. As practically all auxiliary machinery is electrically operated it has been necessary to ensure a supply of current under all circumstances, and a patented arrangement by Carl Meyer has been adopted by which in the case of the shutting down of one dynamo overloading of the remaining plant is avoided and a continuous and adequate supply of current maintained. The switchboards in the main generator room and the emergency generator room are interconnected, so that current may be supplied to the emergency circuits by the turbine-driven dynamos as well as the emergency plant. The emergency circuits include the emergency lighting of 600 lamps, which are distributed throughout the ship, the emergency equipment for the steering gear, the wireless plant and the Anschütz gyro-compass, as well as the alarm bells and the telephone and telegraph installation. Altogether there are 104 motors, having a total of 900 brake horse-power, about the ship. These motors are used for operating the steering gear, warping and cargo winches, lifts, ventilating fans, pumps and kitchen machinery. The specially built electrically operated steering gear may perhaps be briefly described. The rudder quadrant is moved by a self-locking worm which is driven by two steering gears, equal in size and quite independent of each other, each of which is driven by a separate electric motor. One gear is for service and the other acts as a standby, the driving wheel of the latter being placed out of mesh until it is required. In the steering room itself is a change-over switch which connects either of the two gears to the steering wheel on the bridge or to the emergency steering wheel. In the first case the steering engine is driven by one motor generator arranged on the Ward-Leonard system and in the second case by normal current with constant voltage and the speed slowed down to half. For working the Ward-Leonard system there are two motor generators installed in the main dynamo room, one of which is a standby set. Each motor generator is electrically connected to a steering lever on the bridge. The rudder driving motor turns back this lever to the starting point by means of synchronous electric transmission, which has been designed on a patented system and will, it is said, supersede mechanical transmission.

Referring to ventilation, it is interesting to note that the fan motors are started and controlled from one central switchboard in the main generating station, the self-acting starter placed at the sides of the fan motors being actuated by electric transmission from the main switchboard, from which point the speed of the motors may also be controlled. Steam heating is supplemented by electric heating in the first-class cabins, and this is wired on a separate circuit from the kitchen heating and cooking apparatus. Lighting is divided into three groups—all day burning lamps, switch-in lamps, and emergency lamps—the two former of which are wired on separate circuits leading from the main switchboard. The alarm and telegraph installation is carried out on modern lines and the greater part of this equipment is operated by continuous current from the lighting circuits, or in some cases by lower voltage alternating current. The navigation instruments include an Anschütz gyro-compass with a self-steering device by which the steering wheel is directly operated from the compass by electric transmission, and, further, a submarine signalling installation and a wireless equipment provided with a direction finder, by which navigation is possible with the help of wireless stations on shore.

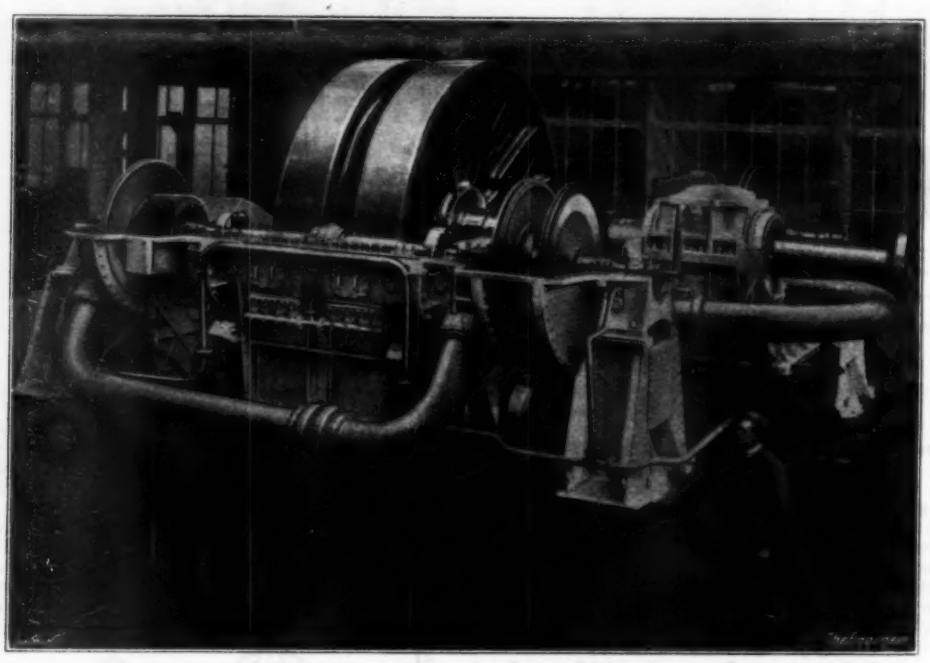


FIG. 10—TURBINE UNIT WITH TOP CASINGS REMOVED

British Association.

No. I.

The Liverpool meeting of the British Association for the Advancement of Science—the ninety-first gathering of the kind—attracted a large and representative attendance of a thoroughly international character, and has proved a great success, at all events, from the superficial standpoint. The attendances at the daily meetings of the many sections were larger than has been the case during recent years, and there are other signs that the Association is making an appeal to a wider circle than it did formerly. Whether this achievement is to be associated with the accomplishment of more useful work in the scientific field is, of course, open to argument, but the balance of opinion among those who are familiar with what is being done is that the anticipations of the founders of the Association are being realised to a greater extent to-day than at most periods of its long history. Our report of the meeting, of which the first instalment appears to-day, will give an indication of the correctness of this estimate of the work which is now being done.

Cohesion and Molecular Forces.

The opening session of Section G (Engineering) was occupied by a joint discussion with Section A (Mathematics and Physics), and Section B (Chemistry) on "Cohesion and Molecular Forces," and attracted an audience of such dimensions that many failed to find admission to the Physics Theatre of the University in which the meeting was held.

Sir William Bragg, opening the discussion, said that the forces which bound atom to atom and a molecule to a molecule, were of fundamental importance to all scientists. Experiment could only deal with aggregates of atomic forces, and every stress that was measured was built up of innumerable forces differing generally in type, in magnitude, and in direction. It was, therefore, very difficult to deduce the laws that governed the behaviour of the simple atom. It might be that in some chemical reaction or some particular change of state the forces might be sufficiently uniform in nature to permit of a definite conclusion being reached. In the class of phenomena which used to be considered as evidence of the action of cohesive forces, such as capillarity, the confusion was considerable ; and in ordinary experiments with rigid bodies it was complete.

In recent years a great advance had been made in the acquisition of powers to deal with the question. As a consequence of the study of radioactivity and of X-rays, it was now possible to handle the individual atom. Knowledge was still very imperfect, but it was now known that there were very strong forces between atom and atom, molecule and molecule, which were limited in their effective range of action to distances much smaller than had hitherto been supposed : small, it might even be, compared to the distances between the centres of atoms as they lay side by side in a crystal. In non-polar compounds in which the separate molecules might be readily distinguished, it would seem that there was the most perfect alignment of the molecules as they were fitted into their positions. A crystal of definite constitution conformed so exactly to rules respecting its angular dimensions that it seemed impossible to imagine its form to be merely the result of an average of tendencies ; and the X-ray results entirely supported the same view. The forces of adjustment could not, therefore, be thought of vaguely as a force between two points each representing one of the molecules. On the contrary, it was nearer the truth to think that the adjustment was made so as to bring together certain points on one molecule and certain points on the other. Molecule was attached to molecule in the building of the structure just as girders in a bridge were joined up to form an empty framework. In most cases the crystal contained molecules which were the image of each other in certain planes, or were derived from one another by a rotation round some axis ; and the arrangement of the molecules gave symmetries to the structure.

The peculiarities of the molecules were, of course, all derived from the peculiarities of the atom. In the case of the molecule there were not only centres of force in different parts, but the strength and

probably the natures varied from place to place. The cleavage plane of a crystal cut across the weakest bonds. The nature of these forces and their typical differences had been the subject of much recent study. There was, in the first place, the effect known as electron sharing, leading to strong and directed attachment, and particularly responsible for the localisation effect. Whatever might be its nature, there was no doubt as to its importance. There were also actions of a different and generally weaker type which were manifested in the binding of molecule to molecule in a crystal; and of atom to atom, as, for example, in sulphur. It was certain that they were present in metals and alloys; and played an important part. It would be difficult to explain the variety in form and properties of the various pure metals if they were to be thought of only as a mass of positive spheres and negative point charges. Lastly, there were the pure electrostatic central actions which were manifested when atoms had become like the atoms of the idle gases either through the addition or substraction of electrons. In those cases the action was an all-round attraction, a positive charge attracting any amount of negatives and *vice versâ*, so that crystal structures containing those effects were full of instances of co-ordination.

In the case of the polar crystal, it was possible to calculate the effect of the electrostatic forces, with some degree of success. Born and Landé, J. J. Thomson and others had made progress in this direction. For every molecule there was, therefore, some most satisfactory way of attachment to its like, whether similarly oriented or reflected or rotated. Whether that arrangement came about during the formation of a crystal, either from a liquid or a gaseous medium, must be a matter of time and environment. Molecule lined up with molecule and the crystal grew; but there might be great differences in the ease with which molecules slipped into their places. Indeed, there was ample evidence of that fact in the different rates of growth of the faces of any one crystal, showing that attachment was made more readily at one point of a molecule than another.

It was possible also to hazard something as to the formation of a colloidal particle. After all, the same forces that built the crystal built the colloid; one would naturally ascribe the latter to an irregular or incomplete action. Possibly the errors were cumulative and ended in the production of some feature common to the whole surface, such as an actual distribution of electrical charge, or some characteristic which drew to itself ions of a given sign; so that the colloidal particle became charged to an extent depending partly on itself and partly on its surroundings. The twinning of crystals was a regular example of that irregularity. The active points as Langmuir termed them were so distributed over the surface already formed that there was more than one way in which fresh molecules could fit into them; and once they began to take up a new way they persisted in it. That explanation was not perfect, of course; but it must be close to the truth.

It seemed clear from such illustrations that broad and soundly based hypothesis had been framed on which to rest explanations of all the phenomena that could be classed under the term "cohesion," even though our present understanding of it was imperfect. Some guide was available for the interpretation of results as well as hints as to how to proceed in researches. The crystal, as a whole, was simply the extension by multiplication of the crystal unit. Examination of the various properties of a crystal, the structure of which was known, reduced the infinite complexity of the subject. Physicists could thus look forward to acquiring a knowledge of the active forces localised at various points of the atom and the molecule. The aim was to substitute that particular and detailed knowledge for previous rough approximations.

Dr. Rosenhain dealt with the subject from the point of view of the metallurgist. By X-ray analysis, he said, it had become possible to study the individual constituents of a crystal, and recently a further step had been taken by a consideration of the results of putting into the space-lattice of a metallic crystal, consisting of individual atoms of metal, certain atoms of another metal forming what was known as a solid solution. In that case certain distortions of the lattice took place, which had been measured and their effect on the properties of the crystal analysed. By very simple assumptions it was then possible to arrive at a fairly complete theory of the internal structure of alloys and thus obtain an explanation of many of their properties. A great light was thus thrown on cohesion in metals. The inherent forces giving strength and ductility were very highly developed in metals. Sir William Bragg had indicated the kind of force by which atoms could be united. In ordinary pure metals the force was purely directional and did not imply any close approach of the atoms to each other, and the inter-atomic distances were all of the same order. In metallic compounds the inter-atomic distances differed widely, and this fact was the distinguishing feature of a metallic compound. Slip and ductility were bound up with these facts. Anything which reduced the facility to slip had a hardening effect. To break the molecules of a metal in which the mechanism of slip had been disorganised, it was necessary to overcome the cohesive force.

There was a limit to the inter-atomic distance at which cohesion could occur between adjacent atoms. If a molecule had atoms at different distances apart, some completely bonded and others not, the effect of strain would only be temporary in the case of the properly bonded atoms, but the others might let go their bond. That, in turn, would throw an additional strain on neighbouring atoms and upset the physical equilibrium of the molecule, producing, ultimately, deformation and a definite viscous flow. From the purely metallurgical point of view, this conception of the nature of amorphous solids was very important as that structure must be present in the materials with which the engineer had to deal. In bonding together crystals adhered so strongly that fracture would take place through the crystal and not through the intermediate structure. That fact raised the question of the value of the maximum cohesion of the crystal lattices to each other. It might be suggested that some atoms would be common to both, but the effect of that arrangement would be to leave the intermediate structure weaker than the crystal. An alternative idea was that where the lattices met each other they were distorted for mutual accommodation. It had also been suggested that between adjacent crystals there were thin layers of independent atoms incompletely bonded and forming a material quite different to the crystal in physical constitution. A difference of that kind could, indeed, be verified. It could not be doubted that recent work, particularly in connection with X-ray analysis, had made it possible to form a much clearer picture of the inner structure of metals than had hitherto been dreamed of, much less accomplished.

Dr. A. A. Griffith said that the engineer approached the phenomena of cohesion and inter-molecular force from the standpoint of elasticity and strength of materials. In a piece of material under no stress the resultant cohesive forces were balanced by the kinetic reaction due to the thermal vibrations. If the molecular configuration were altered slightly, that equilibrium would be upset, so that the new configuration could only be maintained by the application of appropriate stresses to the piece. On the removal of the stresses the original configuration would be restored; hence arose the property of elasticity, or capacity to resist deformation, on which the technical usefulness of structural materials depended. Naturally, the elastic deformation was not unlimited. Thus, under the action of a tensile stress, the cohesive resistance to extension reached a maximum at a particular value of the extension and thereafter decreased. Hence, if the corresponding critical stress were exceeded, fracture by direct atomic separation must ensue. Thus it would appear that the correlation of data on the breaking strengths of materials, with the known magnitude of the cohesive forces obtained by physical methods, should be a comparatively simple matter. Actually, it was far from being so. One reason was that the majority of structural metals were ductile, so that under ordinary stress-systems, which almost invariably comprised shearing stresses, the primary failure did not involve atomic separation at all, but was a failure in shear. The mode of collapse of a space lattice in shear was a subject which appeared to have been studied very little by physicists, so that practically no information on the matter, from the standpoint of molecular cohesion, was at present available to engineers. Even the nature of the action which occurred was not yet established.

In the case of certain materials, *e.g.*, glass, stone, and hard steel, which exhibited brittle fractures running perpendicularly to the direction of the greatest tensile stress, it appeared that the shearing type of failure did not occur. Hence the stress necessary for fracture should be determined by the magnitude of the maximum resultant cohesive forces normal to the fracture. As a matter of fact, it was found, when comparison was made, that a large discrepancy apparently existed, the observed tensile strengths being only a small fraction of the molecular tenacity. Thus, in the case of dead hard carbon tool steel, the applied tensile stress necessary for fracture was only about 160,000 lb. per square inch, while the cohesive forces to be overcome in order that fracture might occur corresponded with a tensile stress of the order of 4,700,000 lb. per square inch. The discrepancy was explained by the existence of minute cracks or flaws and the concentration of stress at these points. Another type of fracture found in brittle material ran obliquely to the principal stresses, and this type of fracture was generally regarded as shearing. It was very difficult however from the molecular cohesion standpoint to realise how true shearing fracture could take place. The essential condition for the formation of a crack would seem to be the existence, normal to its surface, of a tensile stress sufficiently great to overcome the cohesive forces, whence it followed that any fracture following the application of a shearing stress should be due simply to the tensile component thereof. It would be of interest to have the views of physicists on that point.

From the standpoint of the engineer the type of elastic breakdown which occurred in ductile metals was more important. If a sufficiently great tensile or other appropriate load were applied to a bar of such material, the action which ensued might be considered in three stages. The first was the almost instantaneous stage of elastic straining which was comparatively well understood in relation to molecular forces. The third was the stage of molecular separation or fracture, which occurred almost, if not quite, as quickly. The intermediate stage was the stage of plastic or ductile straining, which invariably took a very long time. About the fundamental nature of the latter action practically nothing was known at present, and until that intervening barrier of mystery was broken down it would appear that it must remain impossible to correlate the phenomena of ductile fractures with the known facts of cohesion, as had been done, to some extent at least, in the case of brittle fractures. The problem which awaited solution might be put in the following form. If a metallic crystal were subjected to a shear strain, what was the greatest possible elastic strain, and, in the case of greater strains, by what changes in atomic configuration and orientation did the crystal adjust itself to the new conditions? Further, what was the state of stress in the crystal after the completion of the process of adjustment?

Recent work which he had carried out in conjunction with Mr. B. Lockspeiser, of Farnborough, the results of which had not been published, suggested the explanation that plastic strain was simply the external manifestation of phase changes occurring within the material, and on that assumption it had been found possible to make deductions regarding the number and the nature of the distinct phases. It would appear to be possible for five distinct crystalline modifications of a given pure metal to coexist under appropriate conditions of stress and temperature.

It was the latter conclusion which made the foregoing theory of interest in connection with the present discussion. Questions which occurred at once were, firstly, whether it was likely on physical grounds that phase changes took place as a result of the application of a shear stress; and, secondly, whether it could be said, in the light of existing knowledge regarding the nature of inter-atomic forces, how many distinct phases of a given pure substance were theoretically possible. At first sight, it would appear that phase changes must involve changes in either the configuration or the relative orientation of the atoms. Changes of the former type should be immediately discoverable by means of X-ray examination of strained and unstrained material, but the known method of phase transformation, viz., by the application of shear stress, rather suggested that changes in orientation were the more probable explanation. Even so, the question still arose whether such changes could occur without a measureable alteration in the space lattice. Until solutions to the foregoing problems had been found, it would appear to be valueless to enter on any discussion of the mechanism of the fractures which occurred after plastic straining—in which category fractures could be included. Existing knowledge relative to mechanical tests of materials made it abundantly clear that the types, and even the directions, of the fractures were so closely related to the nature and extent of the previous straining, that any such discussion at the present time would be almost purely speculative.

Sir E. Rutherford commented on the fact that after fifty years' discussion of the subject physicists, engineers and chemists had come to the conclusion that the only direction in which progress could be looked for was the discovery of the methods of interaction between crystals. Many men had spent a lifetime in trying to find an expression for the forces between molecules and atoms, but it appeared that a hopeful line of research was that followed by Mr. G. I. Taylor, who had investigated the elastic deformation of single crystals of aluminium. What the physicist wanted to know was the forces between individual atoms of matter and how they varied in particular cases, and he would have thought that by taking a simple case definite information would be obtained. If such information could be made available it would have great practical consequences.

Sir Oliver Lodge said he thought it was an extraordinary thing that after half a century of work in this field it should be necessary to call a joint meeting of three sections of the Association to ask why, when one end of a stick was picked up, the rest of the stick followed it. Electrical attraction must, of course, have a good deal to do with the phenomena under discussion. Magnetic force was, it was suggested, also involved.

Professor Lindermann, referring to the assumption made by previous speakers, that atoms were linked together at definite points, could not accept that view as correct in all cases. It could indeed be shown to be incorrect in certain gases. From work he had done on the subject he was inclined to agree with the view taken by Dr. Griffith.

Sir Henry Fowler said that those engaged in engineering were concerned rather with actual cases of failure. Their interest in cohesion and molecular forces was that the physicist should put himself in a position to be able to tell the engineer when fracture or breakdown took place why it was that the cohesive forces had failed.

Professor E. N. da C. Andrade said that he had been seeking to get the true coefficient of the viscosity of metals at their melting points. That figure, he believed, would throw light on the subject under discussion.

Professor Langevin agreed with Sir Oliver Lodge that electric forces must play a considerable part in

molecular cohesion. It seemed obvious that as electrical attraction would not give a state of stable equilibrium, magnetism must also be involved. Great progress had been made in the investigation of those two forces, and he believed that further work in that field would enable physicists to get to the bottom of the problem of cohesion.

Professor F. C. Lea discussed the engineering aspects of the subject. Engineers, he said, were simply applied physicists, and very little progress could be made in the direction of understanding the fundamental character of the forces which bound materials together without further guidance from the physicist and the metallurgist. The stresses in materials with which the practical engineer was concerned were those which would break the material by constant repetition, and such forces were essentially different from the static breaking stress. The practical man wanted an explanation of the mechanism of failure in aggregates of molecules under service conditions, and he was not quite sure that the explanation would be given by solving the problem of the cohesive forces in the single atom and the molecule. The engineer had often to deal with materials which were badly treated, which were hot worked and cold worked, and the breaking strength of those materials varied considerably with the character of the treatment. Engineers wanted to go a step beyond the point at which the physicist was now working.

Sir William Bragg, replying to the discussion, said that the physicist realised the needs of the engineer to obtain an explanation of the behaviour of aggregates, but however complex such aggregates might be, their behaviour and the nature of the cohesive force must be derived from the atom. If the atom were understood the solution of the larger problem would follow.

STRUCTURE OF ATOMS.

The question of the structure of atoms and their magnetic properties which was referred to in the joint discussion on "Cohesion and Molecular Forces," reported above, was also raised by Professor P. Langevin in Section A at the meeting on September 17th.

Professor Langevin said that in order to account for magnetic properties it was necessary to assume that each atom or molecule possessed in its normal state a quite definite magnetic moment, which was proportional to the total amount of the quantity of electron moment. From the point of view of classical dynamics a system of electrified particles which participated in thermal agitation could not exhibit when it was isolated, nor assume under the action of an external magnetic field any resultant magnetic moment, and consequently could not possess any magnetic property. The laws of quanta, on the contrary, made it possible to predict the existence of molecular magnetic moments, which were integral multiples of the Bohr magnetor, and permitted mathematicians to develop in a completely coherent manner an electronic theory of magnetism in the same way as a theory of atomic structure and of the emission of spectra had been evolved. Magnetic measurements contributed information regarding atomic structure and atomic models ought to be in quantative agreement with them. The variation of magnetic properties with the state of chemical combination gave important indications and confirmations of the theory. The progressive disappearance of ferro and para-magnetism, when the magnetic atoms—iron, cobalt, platinum, &c.—entered into more and more complex combinations, showed that chemical affinity tended to constitute molecules with no resultant magnetic moment.

VOCATIONAL TESTS FOR ENGINEERING TRADES.

In the afternoon of Thursday, September 13th, Section G held a joint discussion with Section J (Psychology) on the subject of vocational tests for the engineering trades.

Mr. H. G. Tagg said that he had often been asked by engineering employers whether it was possible to devise four or five tests to be given in, say, fifteen to twenty minutes, which would give an indication as to whether a man possessed the special ability to carry out some particular operation in the shops. His reply was, Yes. Personality in industry involved at least four essential factors, all of which must be considered in vocational testing. Those four factors were :—(1) general intelligence ; (2) specific abilities which could not be classed under general intelligence and which were necessary for the performance of some particular operation ; (3) what, for the want of a better term, could be called temperament dispositions ; and (4) the physical factor—physique, sight, &c. An investigation had been carried out in order to determine the part played by those factors—more especially (1) and (2)—in the engineering trades with a view to formulating tests for various occupations. In view of the great variety of trades it was felt necessary to limit the scope of the investigation to the following occupations :—(1) Patternmaking, (2) turning, (3) toolmaking, (4) drafting. A fivefold grading of intelligence was used and the investigation showed that, taking a broad view, a higher average level of intelligence was required from workers in engineering than in any other industry. An attempt was made to arrive at suitable tests by analysing what special abilities were required in the trades under consideration by the following methods :—(1) The investigator, an engineer, carried out all the operations of the trade in order to arrive at some conclusion as to what abilities were necessary for the work ; (2) the psychologist observed the workmen carrying out the operations and attempted to analyse the occupation into its psycho-physiological elements. The tests were made on groups of youths in engineering schools and polytechnics and their respective reliabilities and correlation with the different trades were determined. The general conclusions reached indicated that it was possible to formulate tests that had a high correlation with trade ability and that could be used in vocational selection. That possibility was supported by the work of German and American investigators. In Germany the majority of the larger engineering firms were engaging their employees solely on a basis of vocational tests.

Mr. H. J. Brockenhurst presented a paper of which he and Mr. A. P. M. Fleming were joint authors. This contribution stated that it would appear on first consideration that the aid which psychologists could give to the solution of the problem should relate to all grades of industrial *personnel*. In practice that was not to any great extent the case. Omitting for the moment those factors such as moral worth, &c., not directly associated with production, skilled adult workers were chosen on account of the experience they had obtained in their particular trade, *e.g.*, the type of machine with which they were specially familiar, or the class of work or product on which they had had considerable experience. Those were the factors which made a skilled man valuable, and for which a prospective employer searched. The determination of that experience was not necessarily assisted by psychological tests. The other grades of adult workers were the semi-skilled and unskilled, and as—however unfortunate this might be—there was always a large surplus of such men sufficiently intelligent to undertake quite satisfactorily any work that might be required of them, industrialists could not be persuaded to incur the expense, both in time and money, required for psychological tests. The field that was left, therefore, for the study of selection by psychological tests related to juvenile workers, particularly apprentices in the skilled trades.

Dealing with the selection of juveniles for engineering, he said that the first problem which arose was the psychological analysis of an engineering craft. The general method of psychologists appeared to be to determine separately the factors considered essential to successful work in a given trade, and then devise tests for the detection and measurement of those qualities. Thus, for example, it might be determined that for turners the following qualities were essential :—Aptitude for accurate judgment, concentrated attention, and ability to finish a job neatly. Tests were then constructed to measure those qualities either separately or when acting in combination. In the former case it by no means followed that the tests would be successful in selecting human material when all the factors acted simultaneously. In the latter case, *i.e.*, tests devised for measuring all factors in combination, then the tests ultimately devised tended to become merely a replica of the work analysed. Thus a test for the trade of turning that reproduced all the essential factors gradually developed into something which was very closely akin to the turner's ordinary trade work. Experience indicated that the psychological analysis of an engineering craft, no matter how carefully it might be undertaken, could never take account of all the factors, some of them of considerable importance, which influenced the performance of an individual. Such factors as home influence, influence of friends and workmates, might be quite sufficient to off-set the results revealed by psychological tests.

The authors suggested three essential requirements for success in an engineering trade. Firstly, general intelligence ; secondly, general physical fitness ; and thirdly, interest in the trade. There was reason to believe that psychological tests could be of great help in measuring general intelligence, and industrialists could, to a great extent, rely on such tests in that connection. Physical fitness could readily be determined by medical examination on admission to the works, especially on becoming apprenticed to a trade. The measurement of interest was, however, a much more difficult problem. The present method in industry of determining a boy's interest in, and suitability for, apprenticeship to an engineering trade was to require that he should serve a probation period of usually not less than six months' duration. During that time he was afforded an opportunity of studying the trade, while, on the other hand, the employer could watch the youth's progress. In that way his interest was determined by a process of trial and error. Experience showed that that method, while slow and to some extent clumsy, was, in general, effective, especially in well-conducted works.

Mr. McKay said that vocational tests showed that candidates for engineering appointments headed the list—which either meant that the more intelligent people took to engineering or that it was harder for an engineer to keep his job than any other class of worker. He had found two opposed ideas on the subject of the method of training engineering apprentices. One school favoured the first part of the teaching being in the drawing office, and the other preferred to begin by sending the boys into the works. One explanation of the preference for the drawing office was that it inculcated tidy habits of mind.

Sir Hy. Fowler thought that a greater degree of co-ordination should be brought about between psychologists and engineers. The psychologist was anxious to help in the solution of a difficult problem. He thought that a great deal was to be said for the personal interview which, in his opinion, was the most reliable test available at the present time.

Mr. J. G. Taylor supported the point of view of the psychologist. He said it was now recognised that owing to the introduction of more scientific methods both in the management and equipment of factories, greater intellectual demands were made on the working mechanic. It was, therefore, imperative that his previous education and training should be such as to make him adaptable to modern workshop requirements. The problem of selecting apprentices was more difficult than that of choosing qualified workmen. The almost universal method of selecting apprentices was by the personal interview. It was an easy test to apply, the chief drawback being that it gave no measure of the vocational aptitudes of the candidates. The interview might be used in conjunction with a written examination, and then it was a valuable adjunct. Unfortunately interview technique was only loosely standardised, and variable results were therefore likely to be reached. Even written examinations did not provide a measure of a boy's aptitude for engineering work. In any event, it was an accepted principle of psychological testing that no test should make a demand on the knowledge of the candidate. The test must be for intelligence, and the candidates must be set problems which could be solved without the aid of knowledge or requiring no knowledge which was not common to everyone. It was a test very difficult to devise, but a boy's mechanical ability might be measured by his being asked to undertake a mechanical task new to him, the performance of which was capable of accurate measurement. Some firms obtained apprentices of high quality by selecting only about fifteen out of every hundred candidates. This ruthless method of eliminating all but those who reached the highest standard under an examination test could do no harm so long as there was a large surplus of candidates, but any reduction in numbers would bring with it the need of using a far more delicate instrument to select the right boys. The aid of the psychologist must then be enlisted.

Professor F. C. Lea wanted to see boys selected at an early period of their educational career, so that if deserving they could be sent to a secondary school, and in some cases to universities to be trained for the higher departments of industry. Other boys would go to trade schools and would supply the right type of foremen.

Professor F. G. Baily did not see how a vocational test of short duration could be satisfactory. A period of probation was the best test, as only by watching a boy at work could his fitness for engineering be determined. The personal interview was not valueless, but it ought to be standardised, and that was a difficult thing to do.

Mr. G. H. Miles said it had been estimated that the annual labour turnover due to workers changing from one job to another was equal to the whole working population. A great deal of the waste thus involved was caused by the fact that those concerned had taken up jobs for which they were unfitted. Even that was not the full extent of the evil, as it did not include all those who having once taken up a particular class of work stuck to it in spite of their distaste and unfittedness. Fortunately employers were beginning to recognise that careful selection of workers was essential under modern conditions of specialisation. Careful investigation was being made of the mental and physical demands of the processes, and selection tests were being devised which would indicate the fitness of a particular person for a particular job. In one large firm in the North of England psychological tests had proved so successful that even the foremen, who usually were most sceptical of what they regarded as new fangled notions, had asked that all future beginners should be subjected to the new method of testing. In many countries the subject of vocational guidance was now attracting attention, and it had been placed under State or municipal control in France, Germany, Belgium, Poland, Spain, and Czecho-Slovakia. In the United States the work was being carried out by institutes supported by voluntary agencies. In Great Britain useful work was being done by the National Institute of Industrial Psychology. He trusted the day was not far distant when it would be unthinkable that a child of proved ability should be forced by economic circumstances into an occupation for which it was unfitted. It was national waste of the grossest type, and more productive of unhappiness and discontent than any other factor of the industrial system.

Mr. L. Urwick referred to an inquiry conducted by Professor Kent into the early history of 72 distinguished engineers. At least 79 per cent. of those men had shown an attraction for engineering before they were seventeen years old, 54 per cent. had displayed in boyhood a decided constructional ability, 44 per cent. a bent towards machine construction, and 30 per cent. had built steam engines. There could be little doubt that in the field of mechanical engineering this early interest foreshadowed real

ability, and it should be possible to discover it in any boy by tests occupying a short period rather than by the wasteful and costly method of taking boys into works on probation for six months.

TRANSPORT BY LAND, SEA AND AIR.

In addition to the presidential address of Sir Henry Fowler, an abstract of which appears elsewhere in this issue, in which the question of transport and its indebtedness to science from the general standpoint was dealt with, a group of four papers dealing with special aspects of the transport problem was presented at the meeting of Section G on September 14th.

RAILWAY TRANSPORT.

Colonel E. O'Brien dealt with the future of railway transportation. He reminded the meeting that the average speed of main line passenger trains in this country had increased from 30 miles per hour to 50 miles per hour, the weight of train behind the draw-bar from 100 tons to 500 tons, the weight of rail from 60 lb. to 100 lb. per yard, the weight of locomotive from 50 tons to 147 tons (engine and tender), the heating surface and grate area of boiler from 880 square feet and 15 square feet to 3400 square feet and 41 square feet, and the working pressure from 120 lb. to 225 lb. per square inch. Those figures represented a remarkable increase, but the increase was of extremely slow growth, and in effect the steam locomotive was in principle unchanged since its invention was perfected in 1829. The improvement that had taken place had been wholly in quality of material and method of manufacture; even superheating was applied by Trevithick to a locomotive boiler in 1832, while McConnel in 1854 actually demonstrated its great economy in traffic.

The most radical innovation in rail transport was the application of electric power to transportation, the extensive use of which commenced about twenty years ago. The principal developments of its use were for suburban services and main lines with heavy gradients. There was still a large field for the further extensive application of electricity to suburban traction. A double-track suburban railway, if electrified, could provide a service of thirty trains of eight cars each per hour, equivalent to 15,000 passengers per hour or 30,000 passengers in the two rush hours inwards or outwards. Such a route could serve a suburban population of about 200,000, and a reduction in time of transit from suburb to business centre of about 25 per cent. could be effected economically. At present, but four of the large towns in this country had a portion of the suburban services worked electrically. The cost of operation of those faster and more frequent electrically operated services was but slightly higher per train mile, allowing for interest and depreciation on the outlay involved, than that of the slower and less frequent steam services. The profit per passenger carried, therefore, remained constant, but as in nearly every case the carrying capacity of the line electrified had been doubled and the increased capacity had been absorbed by the increase in passenger traffic, it was clear that such electrifications had been profitable to both railway companies and public alike. A very slight lowering of rates of interest and in the price of the material required for such electrifications was likely to produce a very considerable development in future. There were no engineering difficulties to be overcome, while the only technical point at issue was the most suitable voltage for the third rail; natural development had standardised 600–650 volts in the London area, but if the recommendations of the Departmental Committee of the Ministry of Transport were followed 1500 volts would be used in future round other cities.

The 1500-volt under-contact third rail as now developed was likely to prove perfectly safe and satisfactory and would permit of the future use of either 3000 volts overhead collection or 1500-volt third-rail collection for main line work where required in future.

It would be of interest to consider whether there was any future for main line electrification in Great Britain. The average thermal efficiency of the steam locomotives in Great Britain probably was not in excess of 2 per cent.; tests of modern steam locomotives in first-class condition with the best coal under conditions of maximum efficiency did not reveal an average thermal efficiency of more than 4 per cent. on the basis of the actual coal burned between terminals and exclusive of coal used for lighting up, shunting, &c. Tests had shown that the greater horse-power of an electric locomotive would enable a much higher speed on up gradients to be maintained with heavier trains. The thermal efficiencies of large modern power stations working at 40 per cent. to 50 per cent. load factor might be expected in the near future to be as high as 20 per cent.; allowing 84 per cent. for the efficiency of transmission and conversion, 90 per cent. for the rail, and 75 per cent. for the electric and mechanical efficiency of the locomotive, equivalent to 56.6 per cent. overall, the total thermal efficiency from coal pile to draw-bar for the electric locomotive was about 11 per cent. A general electrification of an average section of busy main line might therefore be expected to diminish the coal consumption by at least two-thirds. This figure was confirmed by independent calculations made by Sir V. Raven in connection with the N.E. section of the London and North-Eastern Railway. He (Colonel O'Brien) had made calculations in connection with sections of the London, Midland and Scottish Railway, which indicated a similar result. The cost of coal for generating current, however, was roughly only one-third of the total cost of current delivered to the locomotive, so that as a matter of finance, as coal prices now stood, coal on the tender and equivalent current at the collecting shoe of the locomotive would be about equal in price after covering all capital charges on the electrical equipment. Economies apart from advantages would, however, be found in the cost of the repairs of the electric locomotive, which would be one-third to one-quarter of those of a steam locomotive per mile run, and in the employment of a single driver per locomotive instead of a driver and fireman. Advantages would also accrue from electrification on which it was difficult to set a money value; local train services would be worked with multiple unit stock, thus greatly reducing locomotive movements at terminals; electric locomotives did not require to turn, which further eliminated shunting. From the traffic point of view, important advantages would accrue due to the characteristics of the electric locomotive, enabling higher speeds to be maintained on rising gradients, from the greater uniformity of speed of passenger and goods trains; from the greater security obtainable on falling gradients by fitting a rheostatic brake on the locomotive, the higher average speed obtainable with goods trains, the greater cleanliness in stations, the availability of an abundant electric supply along the railway for lighting, track circuiting, signal operation, &c. There was no doubt that the electrification of any main line containing gradients of 1 in 300 or greater and averaging over two trains per hour in each direction would at least involve no loss of any kind to the company undertaking it, while the indirect advantages to both the railway company concerned and the electrical industry of the country would be very large. Where the traffic was denser and the grades heavier than those mentioned a handsome return on the capital expenditure might be expected.

From the Ministry of Transport statistics it would be seen that in 1922 the average cost of operation per train mile for all classes of traffic in Great Britain was 10s. 10d., of which the locomotive expenditure on operation and repairs amounted to 3s. 7d. On the assumption that a saving of one-third of the cost of locomotive operation would be effected by electrification the total saving in the cost of operation would be 11 per cent. Owing, however, to the enormous capital expenditure which would be involved in the electrification of the many branch lines with sparse traffic, the economy effected would not be anything like 11 per cent. If a general electrification became possible, due to some invention reducing the capital cost involved, and particularly if the cost of construction of the electric locomotive could be reduced, no doubt the result would react favourably on the public, but for the time being only special sections would be worth electrifying from the railway companies' point of view. If such electrifications could be carried out without loss or even at a small profit the railway companies would be indirectly as well as directly benefited, because the evidence of the success of British electrifications by British firms could hardly fail to stimulate electrification in other countries, bringing at the same time work to this country.

It would appear, therefore, that broadly the physical limitations of the existing railways both in this and other countries forbade any appreciable further acceleration of services or substantial reduction in cost of transit except in a general raising of the standards to the highest at present existent and in certain special directions.

ROAD TRANSPORT.

Mr. A. E. Berriman discussed the position and outlook for road services. It was impossible, he said, to do justice to the engineering side of this subject as represented by the various types of mechanical vehicles used in road transport unless they were seen against a background representing road transport in its relation to inland transport as a whole. Those broad political and commercial aspects of the subject, which must at all times remain the root of its importance, were just now of especial interest because railway freight rates and motor vehicle legislation were both in the melting pot. Half the freight revenue of the railways was derived from the higher grade loads that accounted for only one-fifth of the total weight. If, therefore, the other 80 per cent. was also profitable, it was plausible to infer that those higher-class rates were excessive, or, alternatively, it must be assumed that the railways would be genuinely embarrassed by a serious diversion of that class of traffic. The causes that had contributed to the diversion of freight from the rail to the road were, *au fond*, economic, but they were not limited to a mere comparison of railway charges with road haulage costs. In commerce, the convenience of door to door transport often provided financial advantages that overweighed higher freight rates. Loading and unloading costs were reduced, packing expenses were often materially less, while damage through rough handling and loss through pilfering might be practically eliminated.

While the majority of the vehicles used in Great Britain were petrol-driven for the heavier freight traffic on roads, steam had a considerable vogue in England. One of the chief virtues of the steam vehicle was popularly supposed to be the cheapness of its fuel, but its practical success was probably better founded on other grounds. Theoretically, coal yielded about eight times more heat than petrol for the same money, and, allowing for inherent differences in the two systems, from two to three times as much road wheel energy for equal cost, but, in practice, if the conditions were unsuitable or there was much carelessness, the relative fuel economy of the steamer was not realised in this degree.

One of the lessons that makers of heavy petrol vehicles should learn from the performance of the steamer was the need for providing means for starting the engine from the driver's seat in order to save standing losses with an expensive fuel. If an electric vehicle was a commercial possibility under suitable conditions, surely there ought not to be an insuperable prejudice against electric starters on commercial petrol vehicles.

In the direction of combining a cheaper fuel than petrol with the high efficiency of internal combustion, there had been considerable experimental work, but as yet no established commercial success. Vehicles had been run experimentally with "semi-Diesel" engines, so called. If the use of a heavy distillate, such as kerosene or gas oil, was rendered really practicable under the conditions of road transport, convenience would make it a serious competitor with coal and its cheapness would put it ahead of petrol for use in commercial goods vehicles. Kerosene at 10d. per gallon should yield in an internal combustion engine practically as much road wheel energy for the same cost as high grade coal at 50s. per ton used in a steamer.

AIR TRANSPORT.

Air transport was in the capable hands of Major-General Sir Sefton Brancker. His contribution brought out some important, if familiar arguments. He claimed that the development of air transport was one of the outstanding Empire problems. The basic problem, the education of the public, was still, it was admitted, unsolved. The technical aspect presented many features of interest. New aircraft were being developed which would carry greater paying load per horse-power and be less costly to maintain. The use of heavy oil would effect an enormous reduction in fuel and engine maintenance costs. Operational problems were being studied; present experience pointed to 2000 flying hours per machine per annum as being practicable as well as desirable, and to a 200 per cent. engine reserve per machine. Airships and aeroplances were not rivals. Until now there was but little practical experience of transport work by big rigid airships, and estimates of cost were to a large extent theoretical. Operational costs of aeroplanes were now estimated on bases of practical experience, as shown in the accompanying table. The measure of reliability was similarly capable of estimate. The aeroplane was easily and cheaply handled and was able to land frequently and to deal with local traffic. Broadly, the economic airship stage was never less than 1000 miles; the economic aeroplane stage rarely more than 300 miles. Modern expert opinion called for an airship of not less than 3½ million cubic feet to provide an economic service, and he was satisfied that ships of such size could be constructed easily and handled efficiently. Three types of aircraft were called for by the Air Ministry; one for short-distance work in civilised countries; another for Eastern routes; the third for long-distance, non-stop flights.

Estimate of Costs per Ton-mile (from Latest Statistics), at 100 Miles per Hour.

	Heavy traffic.			Light and fluctuating traffic.		
Annual mileage	2½ million			1 million		
Rate per ton-mile	3s. 6d.			5s.		
Standing charges—						
Administration and fixed charges, per cent.	13.5			18.35		
Salaries, per cent.	20.35	49		27.7	64.35	
Depreciation and obsolescence, per cent.	8.7			10.5		
Insurance, per cent.	6.45			7.8		
Flying costs—						
Maintenance, per cent.	19			13.3		
Fuel, per cent.	24.85	51		17.35	35.65	
Ancillary items, per cent.	7.15			5		

FUTURE OF SEA TRANSPORT.

Mr. A. T. Wall dealt with the present stage of ship design, construction and equipment. He said shipbuilders owed a great debt to the science of pure geometry for their art of "laying-off" ships on paper and in the yard. Pure mathematics in the shape of Simpson's rules was in everyday use in ship designing. It was only slowly, however, that ship construction had evolved from the process of trial and error. When Henry Bell built the Comet the engines produced about 1½ horse-power per ton of machinery; to-day, a torpedo-boat destroyer gave 70 horse-power for each ton of machinery. The earlier marine engines consumed about 6 lb. of coal per horse-power hour, while the modern marine oil engine consumed only $^{4}/_{10}$ lb., or approximately $^{1}/_{10}$ the former consumption, allowing for relative fuel values. The naval architect had many problems to solve. Information on the behaviour of ships at sea was meagre, and questions concerning rolling, pitching and stability required investigation. Strength calculations were becoming more useful to the designer, but were

relative rather than absolute. Much research work in experimental tanks and at sea was required to improve knowledge of resistance and propulsion. In connection with the use of high-tensile steel, the employment of which had been discontinued owing to its low elastic limit, a change in practice was imminent, and a high elastic limit mild steel for shipbuilding had been put on the market.

The Shipping, Engineering and Machinery Exhibition.

No. IV.*

The Welin Davit and Engineering Company, 5, Lloyd's-avenue, E.C. 3, is making a special display of the "Arca" regulator, the principle of which is hydraulic and depends upon the movement of a pivoted lever which is arranged to suppress a jet of water and is self-connected to the impulse receiver. The movement of this lever is produced by the force exerted on it by the impulse receiver, and this movement results in a greater or lesser suppression of the water jet and consequent variation in the pressure of the pipe which supplies this jet. This pressure variation is used and multiplied on a flexible dia-

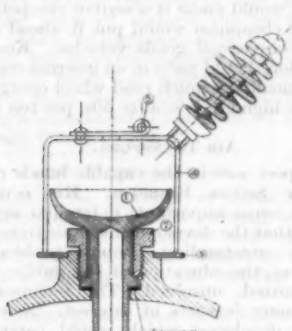


FIG. 36—SECTION OF MOX COLD STARTER

phragm connected to a simple form of slide valve; according to the movement of this valve water is admitted to or released from the hydraulic cylinder, and the movement of the piston in this cylinder is made use of to actuate the valve or other mechanism by which the physical condition is to be eventually controlled. Due to the incompressibility of the actuating medium—water—operation is practically instantaneous. The exhibit at Olympia shows the "Arca" regulator controlling high pressure, low gas pressure, temperature, and humidity. The same firm also exhibits the "Mox" briquette, a heat-producing medium which consists of a small sheet iron capsule of about 1¼in. in diameter and varying in thickness according to capacity up to about ¼in. Into this

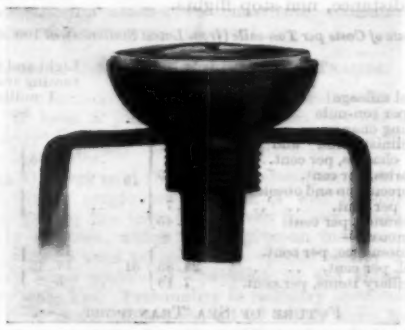


FIG. 37—MOX PLUG

capsule is packed a combination of chemicals which, when ignited, rapidly produce a most intense heat, without the formation of any appreciable quantity of gaseous products of combustion. Ignition is ordinarily produced by means of a patented form of match, the head of which is pressed into a space provided in the briquette case and then serves as a fuse which can be lit either by friction from the matchbox or by the application of a flame. Another little device shown by this firm is the "Mox" cold starter, Fig. 36, which consists simply of a copper plug that can be inserted into the head of a crude oil semi-Diesel engine. External to the engine is a cup to take the briquette above referred to, whilst internally the plug is hollow and arranged so that the oil spray impinges on its surface. The intense heat produced by the briquette, together with the high conductivity of the plug, produces a bright red heat in the internal portion of the latter in a few seconds. The cavity within the plug forms a subsidiary hot bulb which, due to the high conductivity of copper, remains at practically a constant temperature while the engine is running. Other interesting applications of the briquette to a soldering iron and heater suitable for home use are shown. An external view of the "Mox" plug is given in Fig. 37.

The "Auto-Klean" strainer, shown by Auto-Klean Strainers, Limited, New London-street, E.C., is a novel and ingenious departure in straining devices such as are used for removing foreign substances from lubricating and fuel oil systems or from almost any kind of liquid. As its name implies, the strainer is a self-cleaning device in which the straining medium can be mechanically cleaned while in use whether under pressure or otherwise. This is effected by giving a turn to a handle and without breaking any joints in the system. The use of gauze or similar material is entirely dispensed with. The straining medium is sheet metal discs and is, therefore, non-collapsible under heavy pressure. The straining is accomplished by passing a liquid through a series of fine slots in the wheel of a cylindrical cartridge formed by a pile of circular discs mounted upon a central spindle and interleaved by thin washers, the thickness of which is a measure of the straining required. Two views of the strainer are given in Figs. 38 and 40, which show very clearly the method of its construction. The dirt, fluff, or other suspended matter in the liquid is intercepted by the edges of the discs, which in time become coated with the suspended matter. In order to clean the cartridge slots it is merely necessary to give the handle situated at the end of the strainer one-third of a turn. By so doing the discs which are keyed to the spindle are revolved against a series of stationary cleaning

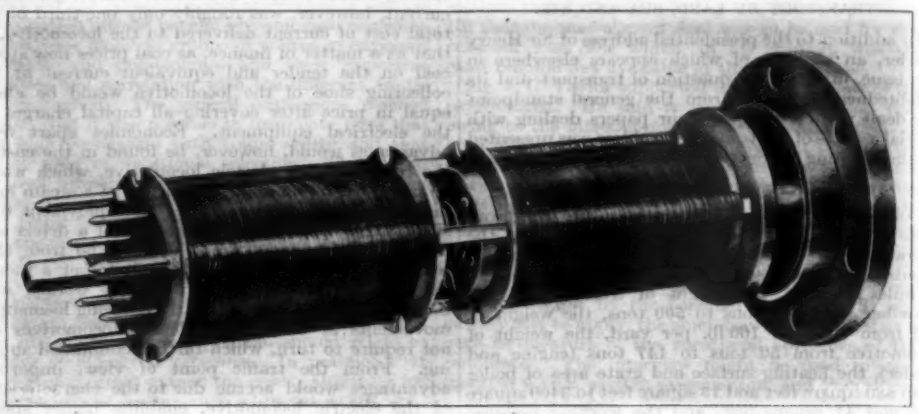


FIG. 38—STRAINING DEVICE OF AUTO-KLEAN APPARATUS

blades of special formation. These blades are slightly thinner than the thin washers mentioned previously

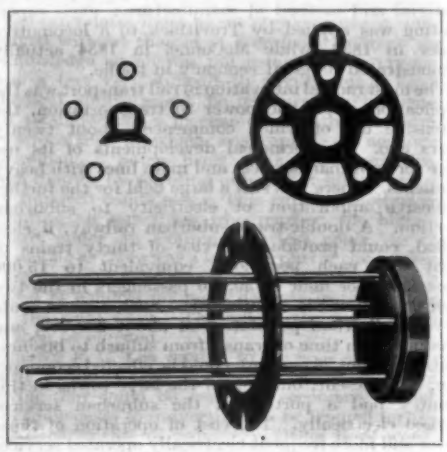


FIG. 40—DETAILS OF STRAINER

and engage the slots as shown. The action of the revolving cartridge is to scrape the dirt from the slots and to carry it clear of the cartridge face. The dirt thus removed settles to the bottom of the strainer

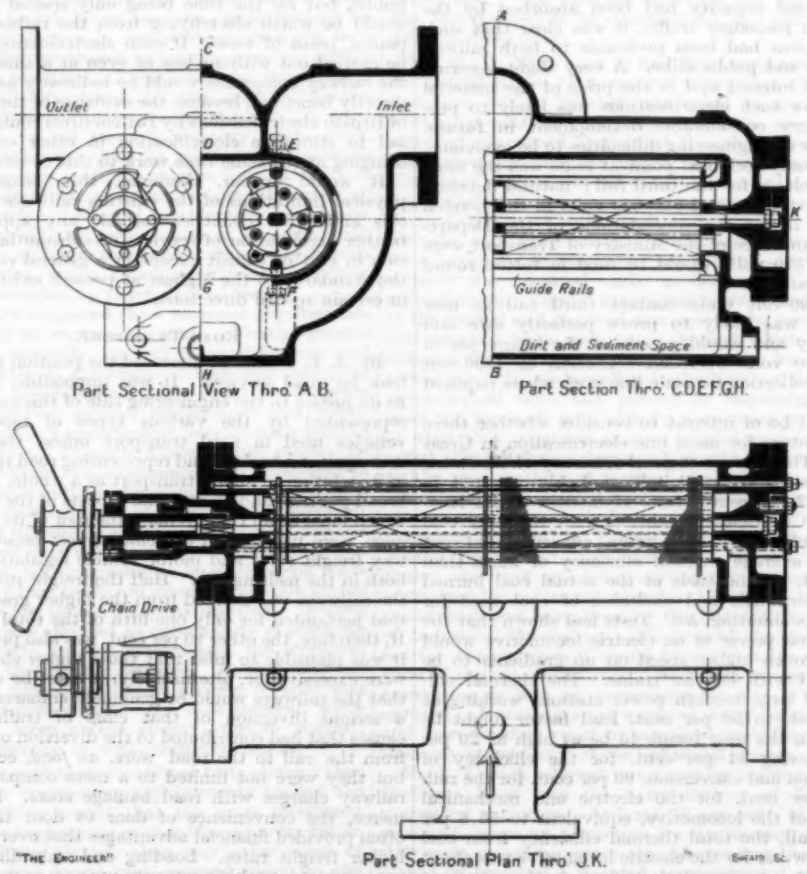


FIG. 39—HORIZONTAL TWIN CARTRIDGE AUTO-KLEAN STRAINER

* No. III. appeared September 14th.

and collects in the sump. It should be mentioned that the cleaning edge of the scraper blades is set obliquely to the periphery of the slot in the cartridge face. The blades have, therefore, a wedging action on the dirt carrying it from the inside to the outside of the slot. Fig. 39 shows sectional views of a horizontal twin-cartridge strainer with 3½in. inlet and outlet passages. The engraving shows clearly the method of construction and means provided for revolving the scraper blades.

The Michell Bearing Company, Limited, South Benwell, Newcastle-on-Tyne, shows examples of

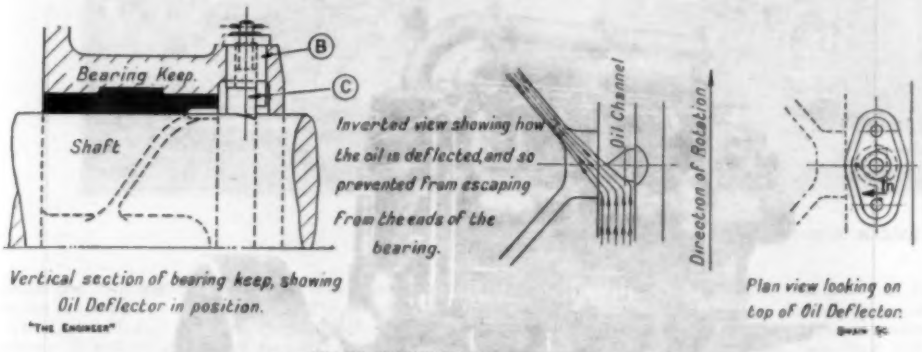

Bearing Keep.
B
C
Shaft
Inverted view showing how the oil is deflected and so prevented from escaping from the ends of the bearing.
Oil Channel
Direction of Rotation
Vertical section of bearing keep, showing Oil Deflector in position.
Plan view looking on top of Oil Deflector.
"THE ENGINEER"

FIG. 41—MICHELL OIL DEFLECTOR

bearings constructed on principles already familiar to readers of THE ENGINEER. A feature of these bearings is the method of supporting the bearing surfaces and arranging the lubrication so that the load is carried upon automatically generated pressure oil films which eliminate metallic contact and reduce the friction to that of the physical resistance which the oil film offers to flow. The Michell propeller thrust indicator has recently been applied by the Admiralty to certain ships. Its inception is due to Mr. J. Hamilton Gibson, the thrust being taken by hydraulic pistons fitted in fixed cylinders charged with oil. The pressure thus produced is recorded by leading the indicator pipe from the interconnected cylinders to a Richards indicator. By means of this indicator it is now possible to record the exact number of pounds or tons required to thrust a vessel of known displacement through the water at any given speed and a better appreciation of the effective horse-power is by this means obtained. Another interesting device shown on the Michell Company's stand is an oil deflector for preventing the escape of oil from the ends of bearings. The usual method of preventing leakage is by means of oil throwers and glands. The Michell oil deflector is intended to prevent the leakage of oil from Michell thrust blocks which are not filled with oil. It consists of a scraper or series of scrapers inserted radially through the bearing keep. The end of the deflector is of a peculiar conical shape, which causes any oil escaping from the bearings to be returned into the journal bearings through ducts. The scraper is made of special hard bronze in a gun-metal bush and is pressed against the shaft by a spring. The arrangement of the oil deflector is shown in Fig. 41.

T. B. Bilton and Co., Limited, Bell-street, North Shields, exhibit a hydraulic pipe-bending machine, with pumps and electric motor complete, suitable for bending copper and other pipes up to 14in. diameter. Among other exhibits are a silent steam water heater, which is constructed somewhat on the principle of the old Giffard injector, in which a jet of steam is mixed in the desired proportion with water and passed through into a bath or other receptacle. The object of the heater is to avoid the disagreeable chattering noise which occurs when steam is admitted into cold water. The appliance fulfils the functions of a stop

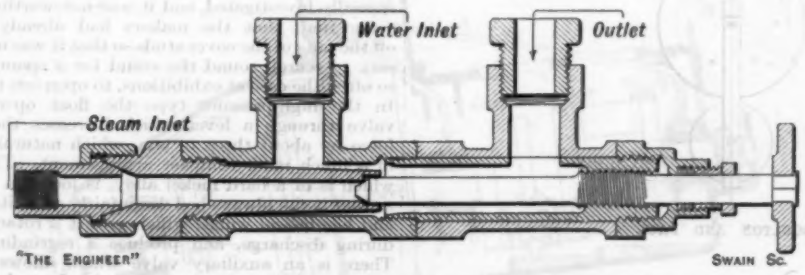


FIG. 42—BILTON SILENT STEAM WATER HEATER

valve, heat regulator and a circulator, and can be fixed vertically or horizontally. It works on live steam at almost any pressure. A sectional view of the apparatus is given in Fig. 42. Another interesting exhibit on this stand is an expansion joint for steam pipes. This consists of an inner and outer sleeve with no gland or packing. The inner end of the inside sleeve is tapered, the thin edge enabling the sleeve to expand under pressure and insuring tightness. The joint is made of gun-metal, and there are no liners to become loose.

The Degory carburetter, of which we give a part-sectional view in Fig. 43, is an improvement upon the so-called "no-jet" carburetter which has been on the market for some time. As regards outside appearances, this appliance bears a marked resemblance to other carburetters. It comprises two principal parts. The float chamber is of the usual type but between the float chamber and the part which contains the choke tube and the throttle valve an arrangement of the passage is provided for controlling the supply of fuel and regulating it for slow running and starting purposes. In the illustration A is the

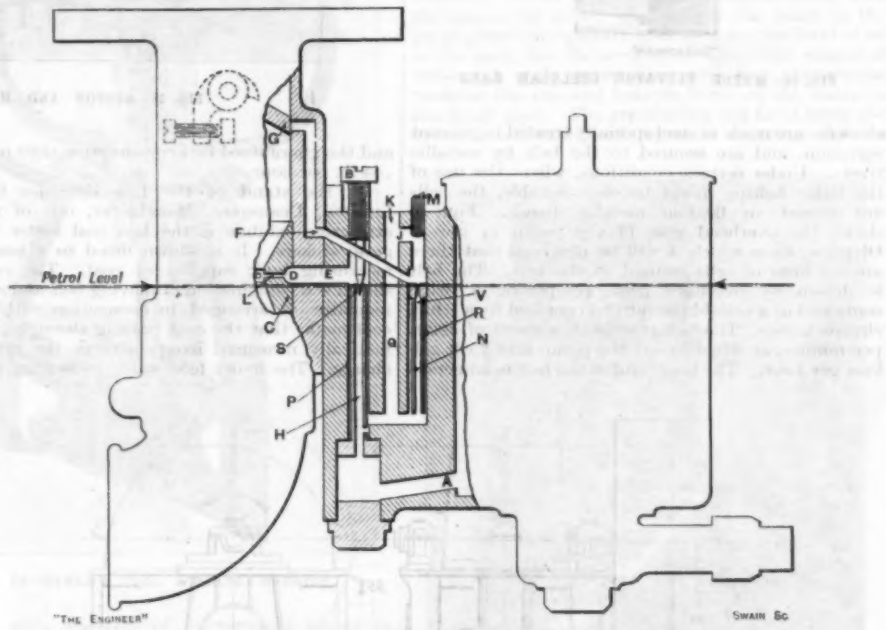


FIG. 43—PART SECTIONAL ELEVATION OF DEGORY CARBURETTER

supply channel from the float chamber; H the compensating orifice; B the control screw which may be either adjustable or standardised; C is the choke tube which has a central circular channel D, communicating with a passage E from the main fuel supply; F is another fuel passage from the small jet V for slow running; G is the throttle valve; J is the air inlet for slow running; K the air inlet for quick running and for the compensating pool P; L is a series of radial holes round the choke tube; M is the screw for controlling the supply of air for slow running; R is the petrol sump for slow running, and N is the restriction tube for slow running. The channel A is the sole inlet for fuel from the float chamber, the fuel passing through the orifice S which, as before-mentioned, is controlled by the screw B. The petrol fills by gravity the pools P and Q, and R serves as a reserve for acceleration and pick-up purposes. For starting and slow running the fuel is picked up above the petrol level at V. It is mixed with the requisite quantity of air by means of the screw M and passes to the engine through the passage F, which has its outlet opposite the throttle valve. The slight opening of this valve, regulated by a stop screw, causes the main air current to pick up the fuel mixture and convey it to the combustion chamber. As the throttle is further opened the pull on the slow-running device diminishes and increases correspondingly in the main supply, the petrol lying in the pools P, Q, and the slow-running sump R is picked up, the slow-running supply ceases, and the air entering at K dilutes the mixture as the suction becomes greater. When the engine speed is reduced the pools are gradually refilled by the compensating arrangement H. A feature of the carburetter which contributes in no small measure to its efficiency, is the novel design of the choke tube through which the fuel enters at right angles to the air supply by means of a series of small holes round the throat. By this arrangement the makers claim that the incoming petrol vapour is drawn through the outer and slower-moving part of the column of air into the central portion, where it is thoroughly intermixed. For dealing with heavier fuels, such as paraffin, a modified form of choke tube is adopted. In this, instead of one main air inlet, there are several smaller tubes, each of which is a miniature choke in itself with twelve small holes for the admission of paraffin to each tube. In this way atomisation is effected more efficiently, and "pinking" is prevented, as there are no large globules of paraffin carried over. The makers are Degory Carburators, 93, Moore Park-road, London, S.W. 6.

Spencer-Bonecourt, Limited, Parliament Mansions, Victoria-street, S.W. 1, has a stand on which there are shown several gas-fired boilers of the type made by this firm, which has already been described in THE ENGINEER. The exhibits include a natural draught town gas-fired boiler 2ft. 3in. diameter by 5ft. 9in. long. This boiler is suitable for a working pressure of 120 lb. per square inch, and is capable of evaporating 437 lb. of steam per hour from and at 212 deg. Fah. The efficiency is said to be 85 per cent. There is no fire-box, and as no primary air is required, back-firing, it is claimed, is impossible. For duties above 1400 lb. and up to 36,000 lb. of steam per hour per unit, on producer gas, blast-furnace gas, or coke oven gas, these boilers are fitted with induced draught equipment. The gas-fired water heater also exhibited is 1ft. 9in. diameter by 5ft. long. It is suitable for a working head up to 100ft., and is capable of absorbing 288,000 to 409,000 B.Th.U. per hour. A Spencer-Hopwood water-tube vertical boiler, 8ft. high by 3ft. 9in. diameter, which is exhibited, is suitable for a working pressure of 120 lb. per square inch, and generates 748 lb. of steam per hour in normal working, or 960 lb. of steam per hour when pressed and coal fired. In addition there is a display of photographs showing installations of Spencer-Bonecourt Kirke waste heat boilers on furnaces of all types, and also on internal combustion engines.

One of the most attractive appliances in operation at Olympia is a water elevator on a tower 40ft. high shown by Boulton and Paul, Limited, Norwich. This elevator is constructed in accordance with the Caruelle patents, the special feature of which is a series of metallic cells, formed as shown in the sketch, and secured to an endless band—Fig. 44. These cells are constructed and shaped in such a way as to obtain a high volumetric efficiency while permitting the release of the entrapped water at the required instant. The elements are placed side by side with a space between them on a specially prepared balata

belt, and the number of lines of cells regulates the lifting capacity of the belt. The water thus entrapped remains in the cells by surface tension, whether the belt is moving or stationary until an angular movement is given to the belt as it passes over the driving pulley at the top. The displacement is also assisted by centrifugal force. The fact that the water will remain in the elements when stationary, and is not dependent upon linear speed to minimise loss by leakage, permits the Boulton elevator to run at lower speeds than chain belts, and accounts for its high efficiency which, on wells of 150ft., is said to be as high as 95 per cent. The

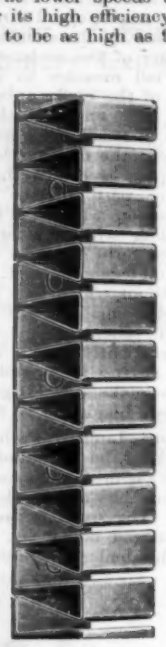


FIG. 44—WATER ELEVATOR CELLULAR BAND

elements are made of steel specially treated to prevent corrosion, and are secured to the belt by metallic rivets. Under certain conditions, where the use of the latter belting might be objectionable, the cells are carried on flexible metallic bands. Fig. 45 shows the overhead gear of the pump in use at Olympia, from which it will be observed that there are six lines of cells secured to the belt. The belt is driven by overhead gear, comprising a drum contained in a suitable casing and operated by a 1 h.p. electric motor. The belt travels at a speed of 500ft. per minute, at which speed the pump lifts 2500 gallons per hour. The lower end of the belt is immersed in a tank of water and is kept taut by means of a weighted pulley. This pulley need not be used except in very deep wells. The submergence of the bottom pulley recommended is 3ft. from the water level to the centre of the pulley. The device runs smoothly and silently, and there seems to be little or nothing liable to get out of order. These elevators are made to lift as high as 300ft.

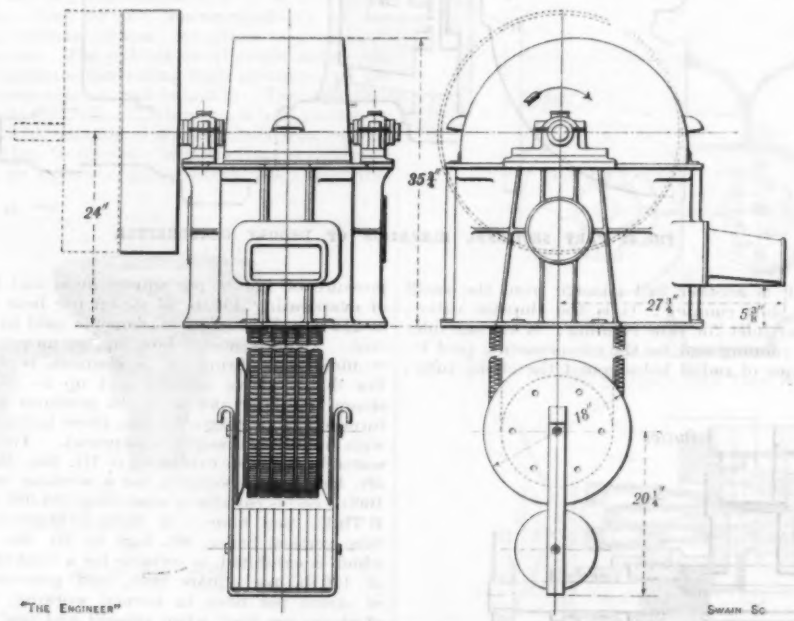


FIG. 45—CARUELLE WATER ELEVATOR—BOULTON AND PAUL

A very fine example of a cold-starting vertical three-cylinder oil engine—165 brake horse-power—is shown by Ruston and Hornsby, Limited, Lincoln—Fig. 46. In connection with this engine no high-duty air compressor is required for the injection of the fuel. The engine is fitted with a Ruston atomiser, and is started from cold without the use of a blow-lamp or the application of any external heat. The valves are all actuated by excentrics, and the valve levers run in oil in an enclosed chamber, giving quiet running and the minimum of wear. The wearing surfaces are large and the lubrication efficient. The engine works on the four-stroke cycle, and the oil is injected by positively driven fuel pumps actuated from the side shafts. The engine is designed to run on the lowest grade of fuel oil, and the guaranteed fuel consumption does not exceed .44 lb. per hour.

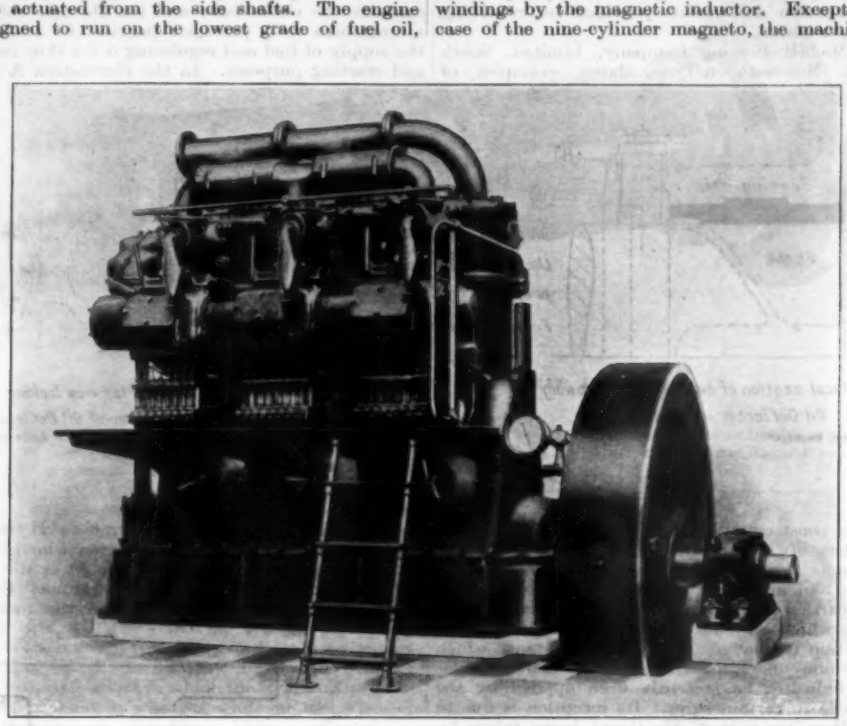


FIG. 46—RUSTON AND HORNSBY 165 B.H.P. COLD STARTING ENGINE

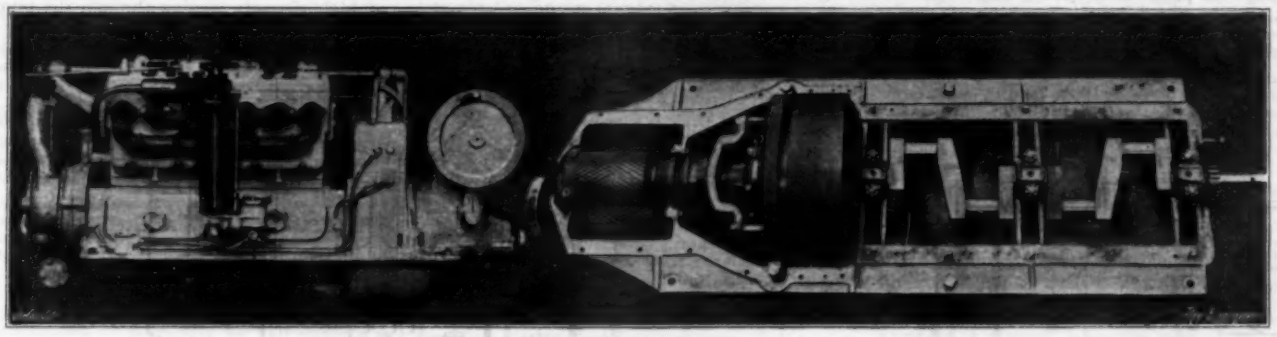
On the stand of the Lea Recorder Company, Limited, Deansgate, Manchester, one of the most attractive exhibits is the Lea coal meter for chain grate stokers. It is shown fitted to a machine for measuring bulk supplies of coal. The cubi-meter shown is a combination of moving belt and automatic regulator so arranged in connection with the Lea coal meter that the coal passing through it is automatically measured irrespective of the rate of discharge. The boiler feed-water measuring apparatus shown on the same stand is a compact device for indicating, recording and counting, having a capacity of 30,000 lb. per hour. It is combined with a V-notch measuring tank and hot well, and is specially suited for fixing the pipe line between an overhead storage tank or water supply and the feed pumps. The flow through the V-notch is automatically controlled by means of an equilibrium valve and float in accordance with the demands of the feed pump, so that the hot well end of the measuring tank is kept full of water at all times. All the above machines are shown in operation.

Automobile and marine engineers and others will find an interesting display of magnetos on the stand of the British Thomson-Houston Company. For eight, nine, twelve and fourteen-cylinder engines the company's magnetos are of the "polar" type. The windings are carried on a stationary laminated iron core built into the main body of the magneto, resulting in a very strong mechanical and electrical construction. Four sparks per revolution are produced by the flux reversals induced in the stationary windings by the magnetic inductor. Except in the case of the nine-cylinder magneto, the machines are supplied for base or spigot mounting, the nine-cylinder machine being spigot mounted. Magnetos for twin, V-twin, three, four and six-cylinder engines, are on view. They are of the rotating armature type. Laminated iron pole pieces are die-cast integral with the main housing and distributor end plate, thus ensuring extreme accuracy in machining and assembling. To ensure accurate spacing and form, the contact breaker cams are machined from a continuous ring. The distributor wheel carries a rotary safety spark gap, so that ionisation of the air gap is eliminated. The distributor is of the jump spark type, and prevents "tracking" troubles. These magnetos can be supplied either for base or spigot mounting. A modified form of this magneto for four and six-cylinder engines has movable laminated sleeves, giving a range of advance and retard of 45 degrees. Impulse starters, designed to facilitate starting heavy engines, are shown. A simple mechanism is provided between the drive and the magneto, which after temporarily arresting rotation for a predetermined period, rapidly rotates the armature, thus producing an intense spark at the plug points. Other exhibits on this stand are permanent magnet lighting generators and combined lighting and ignition sets.

On the stand of Steam Plant Accessories, Limited, 38, Victoria-street, London, S.W. 1, there is a great variety of fittings, including some new types of steam traps. These traps are all of the gravity, or bucket, class, and appear to us to possess several distinctive merits. There are three types, one for low-pressure heating systems, another for pressures up to 100 lb. per square inch, and a third for higher pressures. It was the last-mentioned type that we specially investigated, and it was noteworthy, in this connection, that the makers had already slacked off the nuts of the cover studs so that it was not necessary to search round the stand for a spanner, as is so often the case at exhibitions, to open out the traps. In the high-pressure type the float operates the valve through a lever which increases the closing force by about three to one, which naturaly results in a much more compact arrangement. The valve, which is of a hard nickel alloy, is loose on its stem, so that it can always bed down fairly on to its seating, and has helical wings, which give it a rotary action, during discharge, and produce a regrinding effect. There is an auxiliary valve which allows any air that may collect in the top of the float chamber to escape into a dome at the top of the trap. The air is then blown away to the drain when the trap discharges. In the case of the low-pressure traps the lever system is dispensed with.

Gleniffer Motors, Limited, of Temple Works, Anniesland, Glasgow, is exhibiting several examples of the two standard types of marine motor manufactured by it, ranging from the two-cylinder, 12 to 14 horse-power model to the six-cylinder, 75 to 90 horse-power motor. The larger sizes of engine with 6in. bore cylinders and 8in. stroke have been on the market for some years, but the smaller 4½in. bore cylinder and 5in. stroke model is shown for

the first time. The design of this engine embodies several new features and some account of it may be given. Its general appearance will be seen from the starboard view of the 24 to 28 horse-power model which we reproduce in Fig. 47, while Fig. 48 serves to



FIGS. 47 AND 48—GLENIFFER 24-28 H.P. PARAFFIN MARINE MOTOR

indicate the arrangement of the one-piece bed-plate with the lower half of the gear case. The crank shaft, fly-wheel, clutch, and reducing gears are all shown in position. It will be noted that two side arms run the whole length of the bed-plate, enabling longitudinal engine bearers to be used and a firm foundation obtained. The reversing gear is substantial in design and is incorporated with the clutch and fly-wheel in the gear casing as shown in Fig. 48. When reduction in speed is required double helical gears running in ball bearings and housed in an extension of the gear case are used. A reduction ratio of about 2½ to 1 is generally employed. The clutch is of the self-adjusting type operated by a single hand wheel.

Reference may be made to the cylinders, which are cast in pairs and secured to the crank case by studs in the cylinder flange and nuts inside the crank case. Both the cylinder jackets and the crank case are furnished with inspection doors of ample size. The cylinder heads are detachable and the valve spindles are inclined to the cylinder axis at an angle of 35 deg., which arrangement gives a neat and compact combustion space. Access to the valve rockers and springs is obtained through inspection doors which may be quickly detached. At the aft end of the engine is placed the timing gear with a centrifugal governor mounted on the forward face of the cam shaft timing wheel. This part of the gearing also serves to operate a circulating water pump of the plunger type. An interesting feature of the Gleniffer paraffin engines is the patented vaporiser, which has a throttle control on the main air inlet so that the vaporisation takes place under the partial vacuum which exists between the throttle valve and the cylinders. On light loads vaporisation takes place at a much lower temperature than would be the case at atmospheric pressure. The illustration Fig. 49 shows the method of lubricating the engine.

The Midland Dynamo and Motor Repairs Company, Limited, Volta Works, 64, Belgrave-gate, Leicester, is exhibiting a new machine for winding and forming coils, which possesses the merits of simplicity and ease of operation. This machine, which is shown in Fig. 50, is known as the "Quickway." It is adjustable and can be set up to the required dimensions of the coil in a few minutes. The conductors are arranged to be drawn through a friction clamp which controls the tension. The winding position of the machine is designed so that the wires require practically no handling as they are being fed into position. By means of a friction clutch the machine revolves and draws the wire along the track to form a hair-pin loop which has sides arranged at an angle to suit the slot in the armature which the coil is to occupy. When the requisite number of turns has been made, by the simple movement of a lever through the friction drive, and by the same mechanism, the coil is stretched ready for taping. The time occupied in winding an average coil is two minutes. The advantages claimed for this machine by the inventor are speed, simplicity, and efficiency. No wooden blocks or other accessories are required; the machine is a complete unit and it will deal with all sizes of wire-wound stator or armature coils found in practice. The machine is power-driven, and can be directly coupled to a small high-speed motor or shafting.

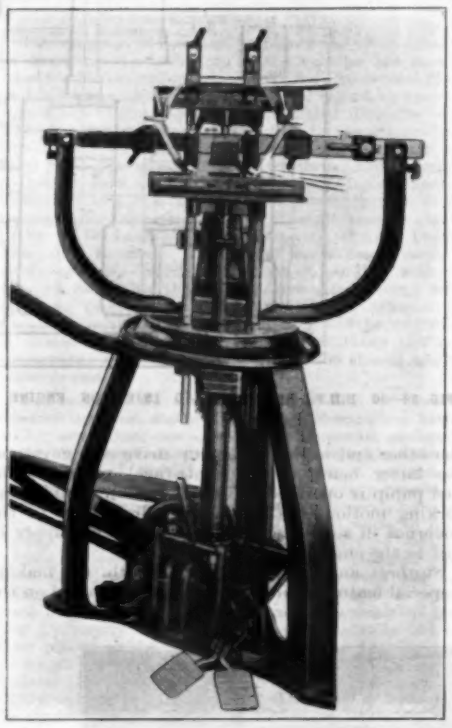


FIG. 50—DYNAMO COIL WINDING MACHINE

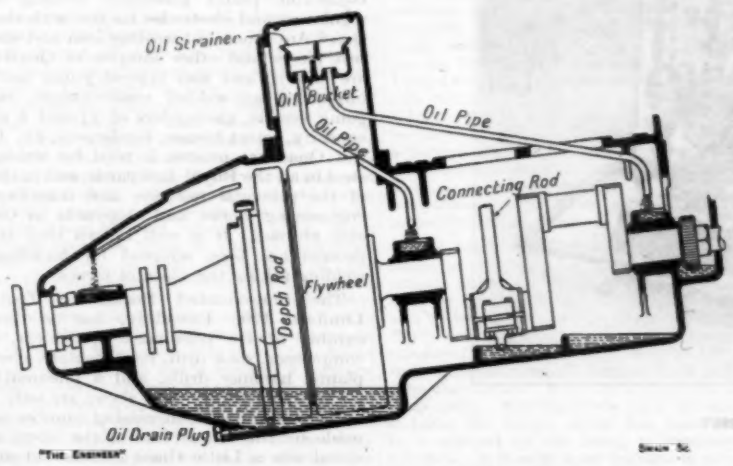


FIG. 49—LUBRICATING SYSTEM OF GLENIFFER MOTOR

On the stand of Walter D. Fair and Co. a demonstration model of a new kind of oil meter is exhibited. The meter was primarily designed to facilitate the control of industrial oil-burning plants, and it has recently been applied to other purposes, such as the measuring of boiler feed water. The meter is actuated by the flow of oil passing from the inlet pipe through a two-way valve into a measuring tank which is calibrated to hold a definite volume or weight of fluid. The measurement of the volume or weight of the oil passing through the meter is obtained by means of interconnected floats, one of which operates during the filling of the measuring tank while the second float is brought into action by the oil reaching correct measurement level, thereby closing the inlet valve and discharging the correct unit of oil into a delivery tank and thence into the outlet pipe. The movement of the second float automatically readjusts the mechanism and records on a dial the measurement of one unit. These operations are repeated automatically during the flow of oil to the meter. A water displacement gauge is connected to the outside of the measuring tank and is provided with a reservoir, the oil in which is in communication with the measuring tank; the level of the water in the gauge glass consequently indicates, not the level of oil in the tank, but the level of an equivalent weight of water. A scale is provided with two graduations marking the top and bottom levels of the water in the gauge glass. The graduations are fixed when the meter is calibrated and represent a certain definite

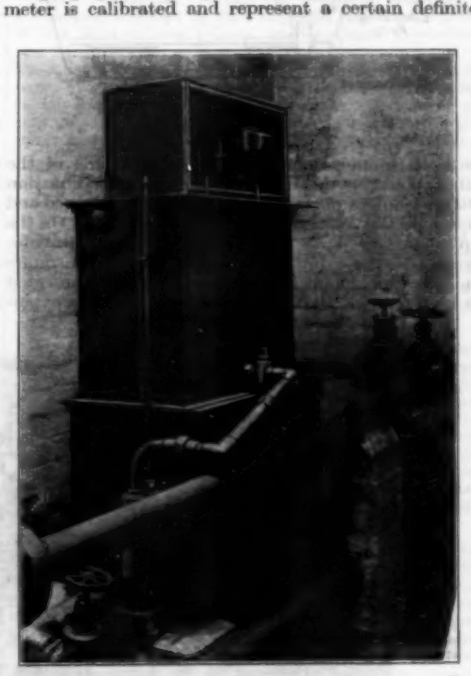


FIG. 51—OIL METER

weight of oil which is the unit of the instrument in pounds, hundredweights or tons. At any time, therefore, the accuracy of the meter may be checked by opening the gauge glass valve and noting whether the water column rises and falls exactly the distance between the two graduations on the scale. An outside view of this oil meter is given in Fig. 51.

An interesting application of the Record engine cycle to a solid injection engine of 50 brake horse-power is shown on the stand of Robert Heath and Low Moor, Limited, Bradford. Illustrations of the engine are given in Figs. 52 and 53, on page 310. Although of the two-cycle type, with this engine crank chamber compression is obviated, excellent scavenging is brought about and forced lubrication is made possible. Reference to the illustrations, one of which shows the engine on the test bed in the makers' works, will reveal that the engine is built up in two more or less separate units operating on a two-throw crank shaft carried in bearings in a common crank chamber. Each unit comprises two parallel working cylinders mounted on top of a large pump cylinder. Inside the working cylinders are two long trunk pistons with conical tops. Each pair of pistons is secured at the base to the larger pump piston, which is utilised to

draw in and slightly compress the air for scavenging and combustion purposes. This air is contained at a pressure of about 5 lb. per square inch in a belt or chamber formed round the cylinders, and at the correct period of the cycle the air is admitted by means of ports in one cylinder through the two cylinders above the piston after the working stroke is completed, thereby expelling the products of combustion through exhaust ports in the walls of the other power cylinder and leaving the combustion chamber full of pure air. These ports are opened and closed by the passage of the working pistons. On the up-stroke the ports are closed and the air is compressed in the cylinders to about 180 lb. per square inch, at which point the finely atomised oil is injected at high pressure by the fuel pump to make an explosive mixture which is fired by the hot bulb. It will be gathered from the above that although there are really four power cylinders they only count as two, and each pair operates simultaneously on its own crank pin. It should be stated that the power cylinders are 5½in. diameter by 10in. stroke, and that there are no valves of any description with the exception of the piston type air distributing valve, which is shown in section in Fig. 52. This air valve is operated by an excentric and suitable mechanism placed midway in the length of the crankshaft. The same excentric also operates the pump in the crank chamber which supplies lubricating oil under pressure to the working parts. The power and pump cylinder castings are separate, the former being water cooled. On one end of the crank shaft is the fly-wheel, and at the other end is the fuel pump drive and governor, the latter being of the centrifugal pattern. The fuel pump is operated by means of an excentric and rocking motion, the latter being linked up to the governor in such a way as to control the supply of fuel to the engine.

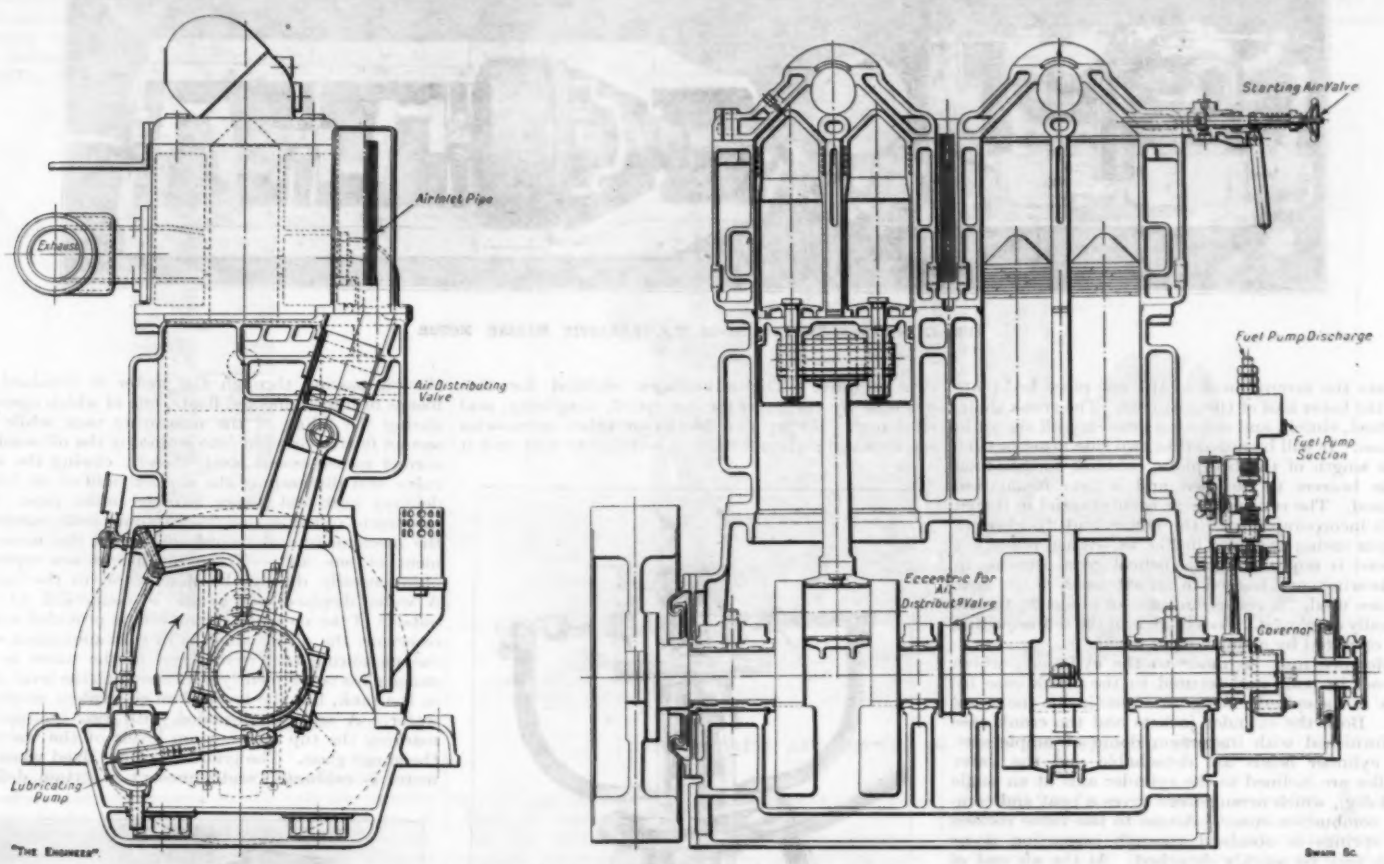


FIG. 52—50 B.H.P. RECORD SOLID INJECTION ENGINE

Stothert and Pitt, Limited, of Bath, are making a special feature of rotary pumps, constructed on the Feuerheerd system. One of these examples is a forced lubrication pump direct coupled to a shunt-wound continuously rated electric motor developing 2.75 brake horse-power at 530 revolutions per minute. The pump and motor are assembled on a single cast iron bed-plate. The pump, which is shown in motion, has an output of 5000 gallons per hour, approximately, against a pressure head of 25 lb. per square inch. Another example is a special hand pump and an electric-motor driven pump, shown with a portion of the Wallsend-Howden steam-raising apparatus. The normal duty of this pump is to circulate oil to the heater with a suction lift up to about 20ft. against a discharge pressure in the neighbourhood of 100 lb. per square inch, and with oil of high viscosity passing through the pump. With the hand pump the operation is performed by one man, the electric drive being an example of the alternative method. Both pumps are shown in motion, the oil fuel being pumped having a viscosity of about 18,000 seconds — Redwood viscometer. In addition to pumps, Stothert and Pitt show models of cranes, including one of an electric horizontal luffing crane—Topliss patent—for shipbuilding yards.

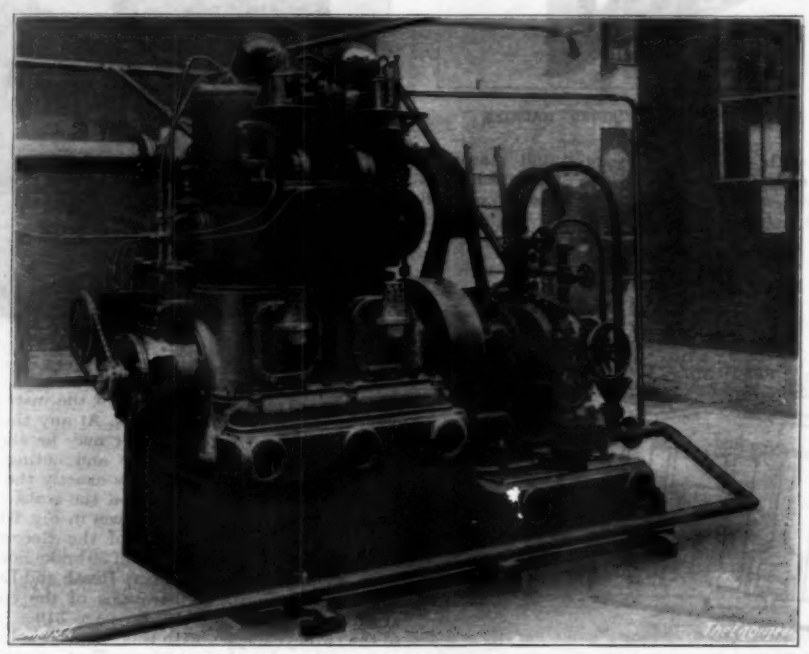


FIG. 53—RECORD ENGINE UNDER TEST

The "victaulic" joint shown by the Victaulic Company, Limited, 28, Victoria-street, S.W. 1, does not depend upon mechanical compression or caulking, but utilises the force it is required to resist to effect a seal, that is the pressure in the pipes seals the joint. The joint consists simply of a flexible ring of special formation enclosed in a metal housing. The in-turned lips of the flexible ring grip the pipe ends, and as the pressure rises so are they pressed more closely into contact with the pipes. The metal housing—formed by bolting two halves together—reinforces the leakproof ring, and it is, therefore, impossible to cause any rupture by a rise in pressure.

The Quasi-Arc Company's exhibits consist of a 60/30-volt petrol generator welding set, current regulators and electrodes for use with the company's Quasi-Arc process of welding iron and steel. Lloyd's test pieces and other samples of Quasi-arc welding are shown, and also typical joints associated with important arc-welded constructions, such as sea-going vessels, gas-holders of 2¼ and 3 million cubic capacity, retort houses, condensers, &c. Incidentally, the Quasi-arc process is used for welding iron and steel in all the Royal dockyards, and in the workshops of the principal railways and tramways, collieries, engineering works and shipyards in Great Britain and abroad. It is well known that the Quasi-arc process has been adopted for building ships, the welding taking the place of rivets.

The Consolidated Pneumatic Tool Company, Limited, 170, Piccadilly, has a comprehensive exhibit of its pneumatic appliances, including a compressor, rock drill, rivet heaters, electric welding plants, hammer drills, and a pneumatic apparatus for spraying paint. The above are only a few of the numerous and ever-increasing number of appliances made by this firm. One of the latest machines we noted was a Little Giant grinder and polisher. This handy little tool is operated by a pneumatic motor and can be fitted with either a grinding wheel or a wire brush suitable for ordinary grinding, cleaning rust, scale, paint work, &c., prior to welding and re-painting. In addition, it can also be equipped with a circular saw suitable for cutting out holes. The weight of one of these machines without the grinding wheel is about 20 lb.

Railway Matters.

IT is stated in *Modern Transport* that Mr. W. W. Grierson, chief engineer of the Great Western Railway, will retire at the end of the current year, but will continue to act as consulting engineer to the company.

THE greater use of ferro-concrete as a substitute for wood has led to some companies, e.g., the Great Western and the late London and South-Western, establishing concrete manufacturing depôts. The Taunton depôt of the former company is now being enlarged.

THE Southern Railway Company has informed the Sheerness Urban District Council that it hopes to have the reconstructed bridge over the Swale completed by the end of this month. Direct road and rail communication with the Isle of Sheppey will then be resumed.

THE Great Western steamship service between Fishguard and Rosslare was reopened on Monday last. At present there is no day service. The disturbed condition of the South of Ireland and the damaged railways are the main factors in its long suspension, but dock labour troubles have also had an influence.

THE Rumanian Minister of Communications has announced a scheme for promoting the flow of goods to the Danube ports by means of six new railway lines, the construction of which is to begin without delay. A number of local lines are also to be made for the general improvement of passenger and goods traffic.

THE railway companies, quite justly, urge that an item on the debit side in season-ticket traffic, often overlooked, is the cost incurred on land for stabling, during the day, the trains used for conveying workmen and business-people from the suburbs into town. This reminds us that in the discussion on Mr. Matheson's paper on the "Glasgow Central Station," at the Institution of Civil Engineers in November, 1908, Mr. Dugald Drummond said that few people knew the heavy cost of hauling the empty carriages to their stabling sidings. It cost some of the railway companies in London £12,000 to £13,000 per annum, and that sum, capitalised at 3 per cent., represented upwards of £400,000 for haulage of empty stock.

A REPRESENTATIVE of the railway coach manufacturers in India stated before the Indian Tariff Board, at a recent meeting, that he was opposed to the protection of the steel industry as at present India was unable to compete with England in the manufacture of coaches. He recognised that something must be done to preserve the Indian steel industry, but claimed that if it were protected, there should be a simultaneous increase in the duty on imported coaches sufficient to neutralise the increased cost of steel. He also urged that the Indian Government should guarantee to place in India a certain percentage of its orders for coaches, the effect of which would be in his opinion, to force English firms to come to India.

WE regret to hear of the death, on the 23rd ultimo, of a man well known in American railway circles and one having many acquaintances in this country and in British possessions. We refer to Mr. Waldo H. Marshall, the President of the American Locomotive Company from 1906 to the end of the war. In his early days—he was born in 1864—Mr. Marshall was the editor of the *Railway Review*, Chicago—then of the *Railway Master Mechanic*, and was afterwards associated with Mr. N. Forney on the *American Engineer*. He joined the railway service in 1897, and when he went to the American Locomotive Company he was the general manager of the Lake Shore and Michigan Southern Railway—one of the New York Central lines.

THREE minor railway mishaps have occurred within the last ten days. On the 10th inst. the vacuum cylinder fell from the tender of the Weymouth to Paddington express when travelling between Dorchester and Yeovil. The leading vehicles on the train and some of the permanent way were damaged, but there was no derailment or personal injury. On the evening of the 12th some wagons, during shunting operations, were derailed at Charrington's coal drops between Leman-street and Shadwell Stations on the Tilbury section of the London, Midland and Scottish Railway. They broke through a wall and three fell 20ft. into the roadway. All the traffic into and out of Charing Cross Station, Southern Railway, was suspended on Sunday evening last owing to a light engine leaving the rails at Belvedere-road signal-box.

THE past week saw the anniversaries of three serious railway accidents. On September 16th, 1887, the Manchester, Sheffield and Lincolnshire Railway Company suspended, as was its usual custom, block-working on the lines approaching Doncaster in view of the increased traffic due to the races. Flagmen were stationed instead and trains were controlled by their hand signals. The driver of one of that company's expresses failed to obey the signals given him and allowed his train to run into a standing Midland excursion train. Twenty-five passengers were killed. The Railway Regulation Act two years later forbade this practice. On September 19th, 1906, occurred the Grantham accident, when one of the down night East Coast expresses failed to stop at Grantham Station. The junction at the north end of the station was set for the Nottingham direction and led on to a reverse curve with lengths of 10 chains and 6.6 chains radius. The train was consequently derailed, and twelve passengers, a postal attendant and the two enginemen were killed. It is now safe to say that there is no doubt the driver had been taken ill, but it remains a mystery why his fireman failed to observe it and to take steps to stop the train. The serious derailment at Ditton Junction, in which thirteen passengers and the two enginemen were killed, happened on September 17th, 1912. A passenger train from Chester to Liverpool was in the charge of a driver whose acquaintance with the road was, to quote Sir Arthur Yorke, "not extensive." He was used to running through Ditton on the fast line, and did not know that speed must be reduced when being turned, as he was, on to the slow line. The train came along at full speed and was consequently derailed. Subsequently there was a fire among the *debris*, which was the worst that had happened up to that time and which could only have arisen from the escaping gas.

Notes and Memoranda.

GREAT BRITAIN is dependent upon the Colonies and America for the greatest part of her food supplies, and it is, therefore, of interest to know that New Zealand has cold storage for over seven million carcases of mutton, Australia has storage for about 300,000 tons of produce, whilst the United States has 550,000,000 cubic feet of refrigerated storage, equal to nearly 6,000,000 tons of produce.

LIQUID oxygen is a bluish liquid, with a density of 1.13; it is strongly magnetic, boils at — 182.5 deg. Cent., and freezes at — 225 deg. Cent. If a glowing splint be placed above the surface of the liquid, the evaporating oxygen causes the splint to burst into flame, and if the splint be lowered into the liquid oxygen itself a lively combustion takes place below the surface of the liquid. If the size of the glowing splint is increased or a piece of glowing cork or charcoal is used the combustion is still livelier and some of the flaming fragments may be thrown out. From these lively actions under the surface of liquid oxygen it is not such a great step to extra rapid combustion or explosive reaction.

THE refining of petroleum uses the largest amount of aluminium chloride at present and seems likely to demand additional supplies of the chloride in the future. This salt converts all unsaturated compounds into saturated compounds. Frequently this conversion is made by throwing out the excess of carbon over hydrogen in the hydrocarbon, whereupon the carbon blackens the aluminium chloride and forms a coke; gases need not be liberated. The most astonishing consequence of this saturating action is that unstable petrol and lubricating oils made from asphalt-base petroleum yield excellent stable products of good colour and odour; in fact, they are almost paraffin-base products.

THE question of how best to reduce the effort involved in operating the brakes on motor vehicles has received considerable attention of late, says the *Commercial Motor*, and is of particular importance with regard to proposed four-wheel braking systems. An added difficulty arises when the brakes have to be applied to the front wheels, it being difficult to arrange a strong and effective mechanical method for operating the shoes which will not be subject to undue wear after prolonged usage. It is, therefore, of interest to notice that the idea of operating the brakes magnetically has been revived in a patent recently granted to Mr. F. W. Lanchester in conjunction with the Daimler Company, Limited. The patent embodies a series of electro-magnets which forces an expanding split-ring into contact with the drum, servo-action being relied upon to produce the necessary braking effect. The simplicity with which such brakes could be controlled is immediately obvious, flexible leads being the only connections required between the vehicle chassis and the brake drums.

THE necessity for the establishment of a refrigeration research institute, states *Ice and Cold Storage*, was harped on by more than one speaker at the annual conference of the Victorian Institute of Refrigeration held at the end of May. Mr. J. Stroud, a former president, pointed out that endeavours had already been made to persuade the Federal Government to establish such a research institute, and advocated that all interested should unite to bring further pressure to bear. Professor Laby, of the Melbourne University, trusted that if any research work were started it would be in co-operation with that now being done at the University of Cambridge. It was a great pity that the information gained by scientists from that University on recent voyages to Australia had not been placed at the disposal of experts in that country. Although the proposed institution was a matter for the Federal Government, he felt sure that they must look to the universities and State Departments of Agriculture for the actual scientific help in the solution of the scientific problems affecting their industry.

DIRECT radio-telegraphic service between the United States and The Hague, Holland, and between the United States and Caltano, Italy, has recently been established. The opening of these services raises the total number of direct radio circuits radiating to European countries from New York City from six to eight, and not only affects Holland and Italy, but provides more direct routes between the countries adjoining them and the United States. The addition of these new circuits to the already existing channels of radio communication to many parts of the world materially advances plans which are being worked out by the Radio Corporation of America to make the United States the centre of a world-wide radio communication network. Because of the centralised situation of the United States, with Europe to the east, South America to the south and the Orient to the west, America enjoys a natural advantage which helps to make it possible to link the principal nations of the world by radio around New York as the pivotal centre. This plan is rapidly nearing completion, there being at present eight connections across the Atlantic and one bridging the Pacific.

THE total sales of tungsten filament incandescent lamps (excluding miniature lamps) in the United States during 1922 amounted to slightly over 200 million—a 25 per cent. increase over the 1921 sales of 160 millions, and within 1 per cent. of the 202 millions sold in 1920. There were less than 3 million carbon lamps sold in 1922, compared with 6 millions in 1921 and 9 millions in 1920. It is apparent that the carbon lamp will soon disappear from the market; it is now a negligible item in the total lamp sales. Manufacturers have developed a colouring material for lamps which has been very satisfactory. It is sprayed on the lamp, is weatherproof, and does not fade. It is even more uniform in colour than natural coloured glass bulbs, which vary in colour, owing to the variation in density and thickness of individual bulbs. Sprayed coloured lamps can be supplied more quickly than natural coloured glass lamps, as the sprayed colour can be rapidly applied to clear lamps in stock, whereas the natural coloured glass lamps usually have to be made to order and often the bulbs have to be specially blown. Only four colours are supplied, namely, a standard shade of red, blue, green and yellow.

Miscellanea.

A LARGE plant for the distillation of tar and other chemical manufacture is to be put up, at a cost of 250,000 dollars, in Winnipeg, Canada.

CONSTRUCTION work on the St. Maurice Power Company's plant at Gabelle Rapids, Quebec, is progressing rapidly, and it is expected that the first unit of 30,000 horse-power will be ready by May next.

THE Gothenburg Harbour Board is planning the reconstruction of part of the Stigborg quay, at the same time increasing the depth to 10 metres so that large ocean liners may use this landing place, especially the big liner Gripsholm, built for the Svenska Amerikalinjen at the Armstrong yards, Newcastle.

A MESSAGE from Reval states that a group of British capitalists is investing £1,500,000 in the construction of a hydro-electric station in Estonia for the exploitation of the Narowa Falls. The total available hydraulic power in the country is stated to amount to 170,000 horse-power, the Narowa Falls representing 90,000.

MORE than twenty American engineering, technical and industrial associations have appointed representatives to attend a national committee meeting which will make plans for United States participation in the World Power Conference to be held in London in connection with the British Empire Exhibition in July, 1924.

THE new plant of the Ford Motor Company, which will be opened at Toronto at the end of this month, will be one of the largest in Toronto, the main building covering an area of 5½ acres, while the entire establishment covers an area of 15½ acres. The plant, which cost in the neighbourhood of 1,500,000 dollars, will be used chiefly for assembling purposes.

THE Post Office system of pneumatic tubes, through which telegraph messages have for some years past been sent from one post office to another in London and from the Houses of Parliament to the Central Telegraph Office, is being developed by the construction of extensions from the Houses of Parliament to the various Government Departments and to Downing-street.

THE production of pig iron in this country during August amounted to 599,800 tons, compared with 655,100 in July, and 411,700 tons in August, 1922. The furnaces in blast at the end of the month numbered 196, a further decrease of 10 during the month. The output of steel ingots and castings amounted to 582,700 tons, compared with 624,300 tons in July, and 528,400 in August, 1922.

AT a conference held at the Boulogne Chamber of Commerce, attended by civil engineers, the chief engineer of the Nord railway system, and Boulogne shipbuilders and business men, an announcement was made by M. Le Trocquer, Minister of Public Works, to the effect that the work of dredging and deepening the inner port would shortly be begun. The State is prepared to bear 58 per cent. of the cost of construction of a new northern breakwater and of other proposed works of general interest.

THE Latvian Government has decided to introduce the metric system as from January 1st, 1924. With this end in view business circles have requested the authorities to import the necessary weights from abroad. It is learnt that the Latvian Ministry of Finance has decided to allow the import of weights and measures. The imported weights will be examined and stamped by the Latvian gauging office, which will see that the weights and measures are of such quality as to guarantee their use for three years.

AN expedition organised by the Northern Exploration Company has just returned to Tromso from Spitzbergen under the leadership of Mr. Carl Saether, a Norwegian gentleman who is also British Vice-Consul at Tromso. The work of the expedition was mainly in connection with the investigation of the mineral wealth of the archipelago. Nickel has been found, this being the first discovery of the metal there. The leader of the expedition was unwilling to give any information as to the extent or value of the seams, or to say in which district of Spitzbergen the discovery had been made.

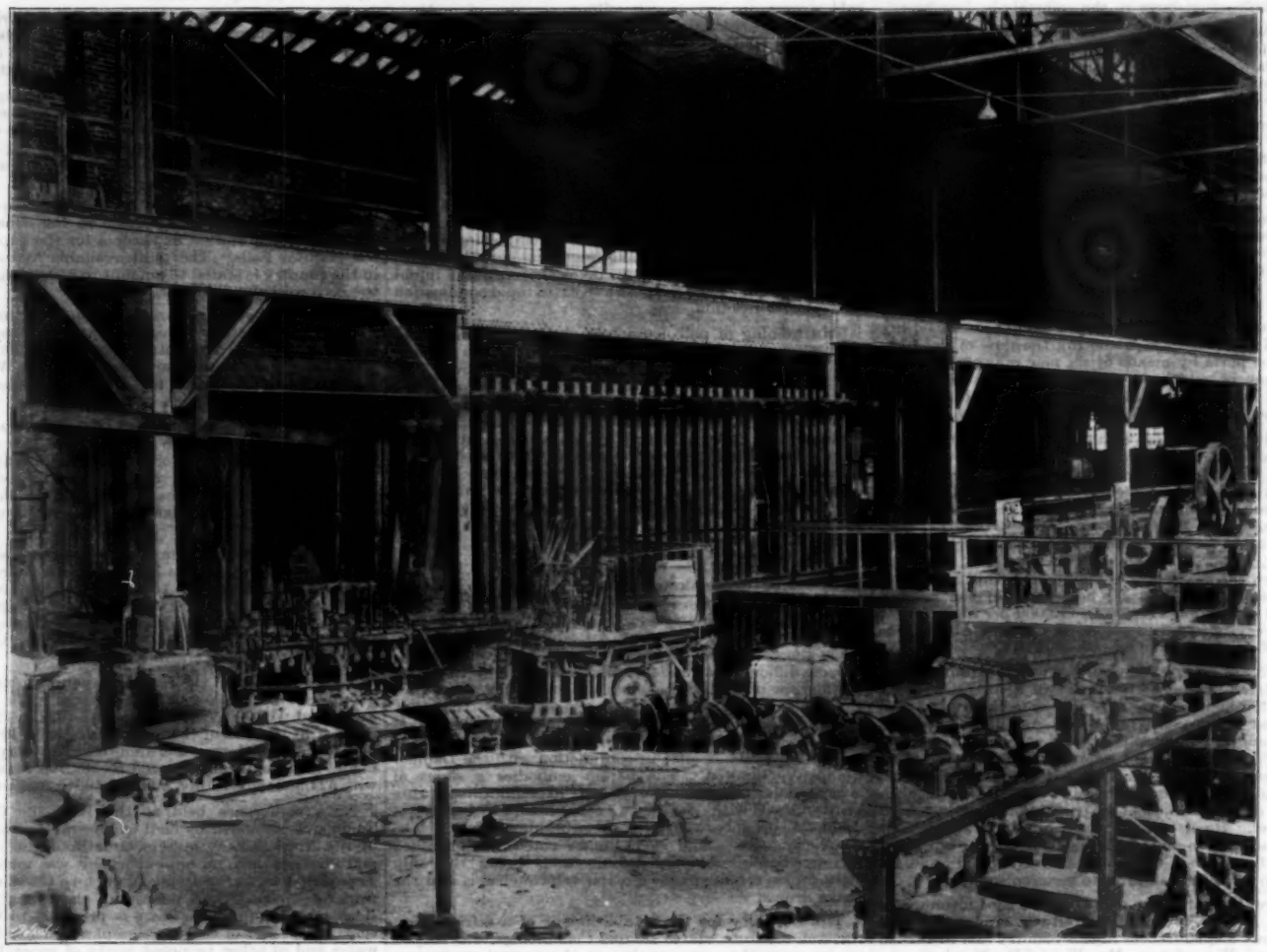
A DEPUTATION of the Indian Mining Federation has met the member for Commerce of the Government of India, and urged the imposition of an import duty on coal from South Africa in order to enable Indian coal to compete on equal terms, especially in the Bombay market. Representatives of the railways, port authorities and Indian commercial representatives from Bombay were present, and after some discussion it was agreed that the question was primarily an economic one, and that the coalowners and the port and railway authorities should collaborate in order to reduce the cost of Indian coal.

A COMMITTEE formed by the Government of Ontario to study the position of the iron ore mining industry in Canada reports that the "steel industry is wholly based upon a rapidly dwindling supply of foreign ore, approaching within distance of extinction," and it recommends a bounty of 1 cent. per unit of iron, payment to be shared by the Province and the Dominion, with the appointment of a geologist and mining engineer to study deposits and methods of mining and preparing the ore, including low-grade ores, together with the repeal of certain sections of the Mining Acts which at present discourage the investment of foreign capital in the mining of iron ore.

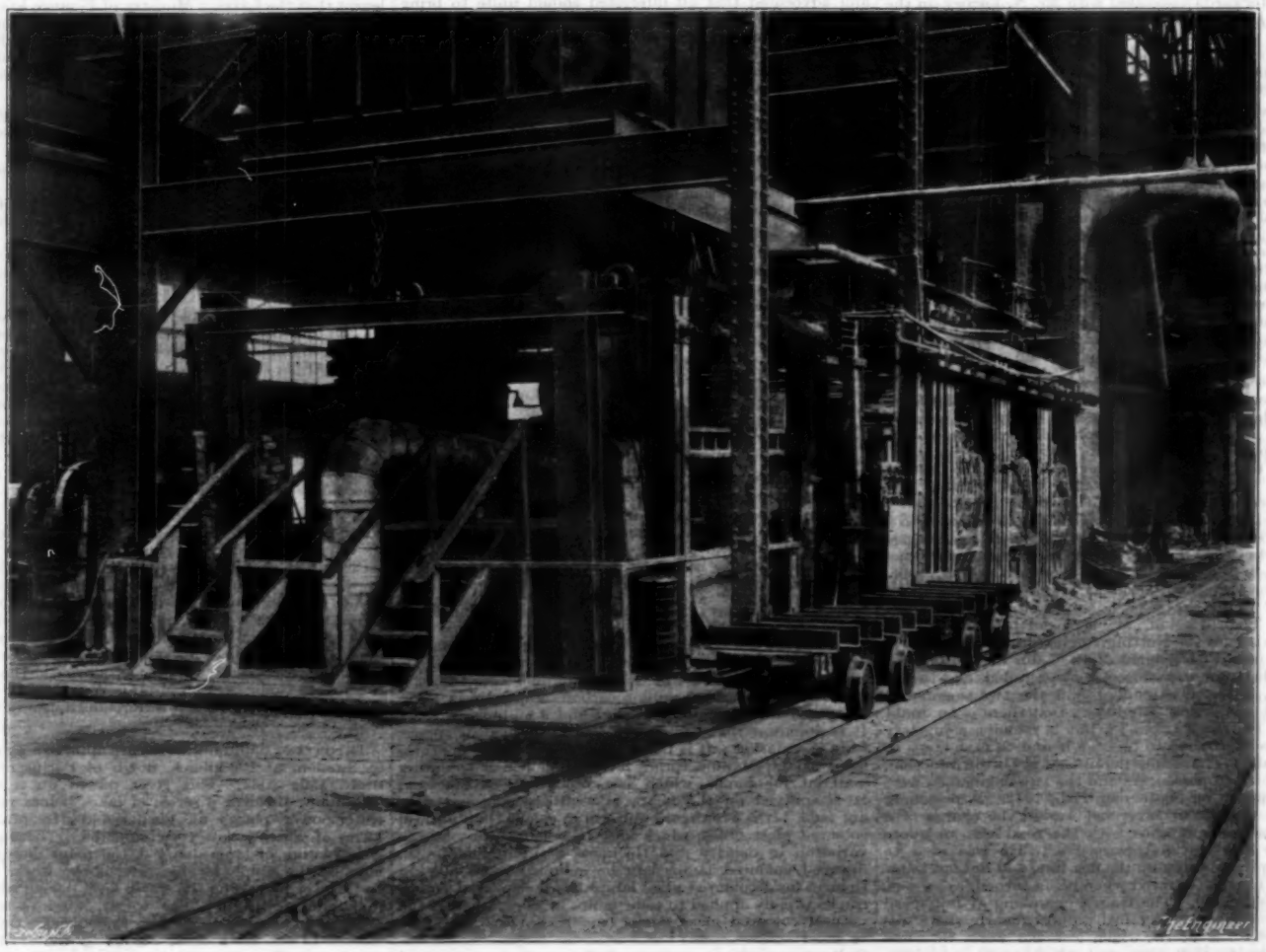
IMPORTANT damming works are approaching completion in Sweden, at 100 kiloms. north of Porjus on the river Stora Lule Aelv. This river passes on a stretch of 70 kiloms. through a series of lakes before reaching the water-power plants at Porjus and Harsprsanget, the latter of which is not yet completed. The object of the construction of large dams at the point mentioned is to equalise the supply to the water-power works in summer and winter by raising the water level during summer by a maximum of 16 m. The works, were commenced in 1919, and will cost nearly Kr. 13,000,000. On the whole stretch of the river from Porjus to the Bothnian Gulf energy totalling 700,000 horse-power will be available after the completion of all the plants.

THE RARITAN COPPER WORKS, PERTH AMBOY, U.S.A.

(*For description see page 298*)



CASTING SIDE OF REFINING FURNACE



COPPER FURNACE

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The Engineer

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CHINA.—KELLY AND WALSH, Limited, Shanghai and Hong Kong.
EGYPT.—CAIRO EXPRESS AGENCY, near Shepheard's Hotel, Cairo.
FRANCE.—BOYVEAU AND CHEVILLET, Rue de la Banque, Paris.
CHAPELOT AND CIE., 136, Bld. St. Germain, Paris.
BELGIUM.—W. H. SMITH AND SON, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.
INDIA.—A. I. COMBRIDGE AND CO., Bombay; THACKER AND CO., Limited, Bombay; THACKER, SPINK AND CO., Calcutta.
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THE ENGINEER.

SEPTEMBER 21, 1923.

Main Line Electrification.

WE have no doubt that the paper which Colonel O'Brien read before Section G of the British Association on September 14th will be studied by many of our readers. The author has been connected with railway electrification from its earliest days, and there are few men who combine such a complete knowledge of railway working with a complete knowledge of the electrical problems involved. Too often we have to listen, on the one hand, to men whose advocacy of railway electrification springs solely from their devotion to electricity, and, on the other hand, to men whose objection to electrification arises from a belief, amounting to adoration, in the steam locomotive. In both that intimate acquaintance with railway problems which is necessary to the formation of a correct judgment is frequently lacking. It cannot be too constantly insisted that the locomotive *per se* is only part of a very complex organisation and that the consideration of it by itself, and apart from all the other factors that affect its operation, is likely to lead to hopeless errors. A few months ago we endeavoured to show that those who were clamouring for higher speeds and who insisted, pertectly rightly, on the abilities in that direction of the steam locomotive, had overlooked the fact that there is an "economic" speed which it does not pay the railways to exceed. We mention that case as an example of the kind of error into which one-sided advocates may fall, and we notice with some satisfaction that Colonel O'Brien confirms our view that an appreciable further acceleration of services is improbable.

It is because Colonel O'Brien is in a position to hold such a judicial position between the locomotive itself and the railway as a whole that his observations on main line electrification are particularly acceptable. Possibly, he does not do quite full justice to existing steam locomotives and probable developments of them, but he does not do, as so many advocates of electrification have done, both depreciate the steam locomotive and unduly exalt the electric locomotive. We confess that we are surprised that he should find the thermal efficiency of a modern steam locomotive in first-class condition no more than 4 per cent., but if he errs on the low side in that direction he seems to us to err in making the efficiency of the electric locomotive only 11 per cent. Our own estimate, based on Sir Vincent Raven's latest locomotive, and published in our issue of November 24th, 1922, was between 12 per cent. and 14 per cent. for the same conditions—that is to say, from coal pile at the power station to locomotive draw-bar. But even accepting our higher figure the advantage of the electric locomotive from a *financial point of view* would, Colonel O'Brien points out, be inconsiderable and if, as we think, he has rather underrated the steam locomotive it would disappear altogether. The cost of coal for generating current is, he tells us, only one-third of the total cost of current delivered to the locomotive, so that, as a matter of fact, "coal on the tender and equivalent current at the collecting shoe of the locomotive would be about equal in price after covering all capital charges on the electrical equipment." We ask no better confirmation of the opinion expressed in the leading article to which we have referred that any coal saving by electrification of railways was problematical. We must look, then, in other directions for the economic benefits of main line electrification. Here, also Colonel O'Brien is strictly impartial. He shows the advantages appertaining to electrical locomotives in the reduction of maintenance, the decrease in the number required to work a given service, and so on; but after all he reaches the conclusion that the 11 per cent. possible saving would be greatly reduced by the enormous capital expenditure involved. Thus, in the long run, his figures show that on the economic basis—we are considering the matter from that standpoint alone—the electric locomotive has nothing to commend it in this country. It is worth while recording that when Mr. Dalziel, of the then Midland Railway, worked out the cost of working the Derby to Manchester lines electrically, he found that the figures showed a debit balance of no less than £3000 per year. Honestly unable, as an impartial and learned judge, to find a direct economic value in the employment of electrical locomotives, Colonel O'Brien urged as an argument in favour of main line electrification that it would encourage our foreign trade by leading to orders being placed here, "because the evidence of the success of British electrifications by British firms could hardly fail to stimulate electrification in other countries, bringing, at the same time, work to this country." We shall make no further comment on that policy than to observe the novelty of the proposition that our railways should be employed, and possibly made bankrupt thereby, as demonstration platforms for the electrical engineering trades.

One has only to look at the figures given by Colonel O'Brien to find confirmation of the belief that suburban electrification is an admirable thing, but it should not escape attention that it effects no saving in the net cost of carrying passengers. The profit per passenger remains constant, but as the number of passengers has enormously increased, the total profits are much greater than before. Can we look for similar developments through main line electrification? With few exceptions—exceptions that may be regarded as quasi-suburban like the London-Brighton service—we believe not. It is very improbable that the passenger traffic would be appreciably augmented by electrification, and it is difficult to see how, in present circumstances, the goods traffic could be, thereby, increased. If there is no financial reason why electric locomotives should be used, the only cause for employing them is the failure of the steam locomotive to meet the necessities of the day. We persist in our opinion that the steam locomotive has not reached the limit of its possibilities, and the internal combustion engine has hardly begun to develop them. But if either of these types can do, or could do, all that may be expected from an electrical locomotive, then to adopt the latter in face of the much greater capital cost involved and high total maintenance charges would, surely, to say nothing of such drawbacks as dependence for a whole service upon a few power centres, be a grave error. It is impossible to doubt that the independent unit is better than the dependent one, and there can be no question that when the internal combustion locomotive has been brought to perfection—as it will be—its superiority for main line work to the electrical locomotive, whose economy is squandered in transmission losses and whose reliance is upon a distant power station, will be unchallengable.

Corrosion.

THE Manchester meeting of the Institute of Metals produced, among others, a lively discussion on corrosion, in which the old controversy between the electro-chemical and the purely chemical or oxidation theories was revived. From the viewpoint of engineers, who constitute an important section of the membership of that Institute, it

might well have been expected that after many years of patient research, so fundamental a question would have been decided. Anyone, not himself an expert in this particular matter, listening to the discussion between Dr. Bengough and Mr. Evans, must have found it difficult to make up his mind on which side the balance of truth really lay—so far as this discussion was concerned, the honours seemed to be remarkably even. At first sight, such a state of scientific indecision would seem to portend little good to the practical advancement towards the solution of one of our most pressing problems—the prevention of damage and destruction to our metallic structures by those insidious forces which seem to lie in wait for the unwary at every turn. As Sir Robert Hadfield has repeatedly pointed out, the economic importance of this problem in regard to iron and steel alone is very great, the destruction of many millions of pounds' worth of property being attributable to corrosion every year. In non-ferrous metals, although the scale of loss is smaller, its importance is yet very great, and it seems likely to attain still greater importance at a time when metallurgical advances are bringing such metals as aluminium and magnesium, or rather their alloys, seriously into the field of engineering materials.

Whatever the scientific explanation of the processes of corrosion may be, the engineer is not so much concerned with the fundamental theory as with methods of prevention of corrosion or means of protection from its ravages. Now the importance of an understanding of the fundamental theory lies in the fact that the two views which are so vigorously contested lead to two entirely distinct lines of advance on the practical side. If the electro-chemical theory be correct, then immunity from corrosion is to be sought in the use of extremely pure metals, since in these alone may we hope to be free from those electro-chemical differences to which the electro-chemical theory ascribes the genesis of corrosion. On the purely chemical theory, on the other hand, great purity in the metal should not serve as any real protection, and what has to be looked for is a satisfactory protective coating. This would appear to be an important distinction, but from the practical point of view the difference is, fortunately, not very great. We may realise, to begin with, that advances have actually been made along both lines. Thus it has been sought to produce commercially a material which is a near approach to pure carbonless iron, and such material is made on the large scale and great claims are advanced for its power of resisting corrosion. In certain situations, the claims made for it appear to have justified themselves to some extent, while in other circumstances this type of iron has failed as rapidly as ordinary less pure varieties. The material, at best, however, is soft and relatively weak—so much so that for many important purposes its use in structures or machines could not be considered. This brings us to a fundamental difficulty with which we should be seriously confronted were it found that immunity from corrosion lay solely in the direction indicated by the simple electro-chemical theory. Metals of high purity are not only difficult and expensive to make, but they are mechanically unsatisfactory, if not entirely useless. With the exception of high-purity copper, used on account of its electrical conductivity, engineering practice employs few, if any, pure metals; for the requisite combination of strength and toughness, the use of alloys—often of specially heat-treated alloys—is essential, and in these no degree of purity can prevent the formation of electro-chemically different regions. The abandonment of alloys, whether ferrous or non-ferrous, in modern engineering is, of course, unthinkable, so that whatever the real cause and nature of corrosion, we cannot take the path indicated by the electro-chemist.

Fortunately, advances in the development of protective coatings have also been made, and some are at the present moment receiving much close attention. Paints, enamels, varnishes and similar coatings, together with their obvious defects of insufficient durability and inadequate imperviousness to moisture, are familiar to all. Metallic coatings also, whether applied in the molten condition, or electrolytically, or in the form of vapour or spray, are also well known and in some measure successful and valuable. The most important recent advances in the battle against corrosion have been made in a direction which, apparently, is quite different. The bright metallic surface of a polished piece of "stainless" chromium steel does not suggest the presence of a protective coating, nor does the surface of aluminium, even when specially treated in such a way as to thicken and strengthen the protective film which, in that metal, always exist to a certain extent. Yet it is extremely probable that in both these cases, as in other alloys recently developed for the purpose of resisting corrosion, a thin film of an oxide nature exists on the metallic surface, so that the metal provides its own protective coating. In the case of the chromium steels this explanation is not, perhaps, fully established, but in view of the close analogy with the manner in which aluminium protects itself from chemical attack, it seems most probably the true explanation of the remarkable properties of the new steels. If this view is correct, we have here the most perfect method of providing a metal with a corrosion-resisting surface coating. It overcomes the difficulty of having to use an extremely pure simple metal, since it can be applied to alloys of high strength, and it avoids the risk of imperfect coatings, since the metal automatically protects itself. As yet, these rust-resisting steels are severely limited as to their general usefulness by the serious question of price, but that difficulty is likely to diminish rapidly, as new sources of raw material and improved methods of manufacture become available. Moreover, we are, as yet, limited to a very few grades of such steel, but even with that limitation, their applications are growing from day to day. That other steels and alloys, making use of the same principle, can yet be discovered or developed appears to be almost certain. Much yet remains to be done in that direction, but at least the practical outlook would appear to be brighter than the state of divided scientific opinion on the subject of corrosion would suggest.

Transport and Its Indebtedness to Science.*

By SIR HENRY FOWLER, K.B.E.

I FEEL that it is right that the Engineering Section of the Association here in Liverpool should devote one of its sessions to the subject of traction. There is no city in the Empire, or in the world, which is so dependent on traction in one way or the other as the one in which we are meeting to-day, and I can also say without fear of contradiction that there is no city in the world which has acted as so great a pioneer in traction development as this one on the Mersey.

We are perhaps too apt at the present time to forget the obligation which the world owes to transportation, so commonplace have the improved methods become. It has been said that effective transportation is one of the great aids to civilisation, but it must not be forgotten that all movement of material from place to place is economically waste as far as the dissipation of work is concerned. The transportation which aids civilisation is that which cuts down the wastage of power to a minimum and which reduces the time occupied in carrying this out. It is here that science has helped in times past, and will help increasingly in the future if we are to go forward. If we take the definition of science as "ordered knowledge of natural phenomena and of the relations between them," as given by W. C. D. Whetham in the "Encyclopædia Britannica," we shall easily see how transportation has been dependent upon it.

It may be said roughly that transport is mainly dependent upon three things: the method of propulsion, the material available for use, and the path over which traction takes place. I cannot deal fully even with one of these, and propose to confine my remarks to the first two, which are the ones I am best acquainted with.

The greatest step forward—wonderful as some of the achievements of aeronautics have been of recent years—came with the development of the steam engine. Like most great achievements in the world, it was not a lucky and sudden discovery of one individual, although here as elsewhere we associate the work with the name of one man especially. This has usually been the case, and without wishing to detract from the work of the individuals who are fortunate enough to utilise the ordered knowledge available to the practical use of man, one must not forget the labours of those who have sought out that knowledge and have given it freely to the world, thus placing it at the disposal of the one whose imagination and creative faculty were great enough to see how it could be utilised in the service of man.

From the time of Stephenson the progress in propulsion on rails by steam locomotives was steady, if slow. The investigations for a long while were largely confined to the question of expansion and condensation, and although the results attained were noteworthy in the case of steamships, on the rail—to which for the moment I will confine myself—there was little advance in the principle of propulsion; but, as I shall show later, the improvements in materials allowed a steady growth in power and size. Although work was done by compounding and using higher pressures, the greatest advance has come to steam locomotives by the use of superheated steam. This was no new thing, for Papin in 1705 seemed to have an appreciation of its value. As pressures and the resultant temperatures increased there came difficulties with lubrication. With the increased use and knowledge of mineral lubricants Dr. Schmidt was in 1895 able to devise methods of using superheated steam which have been of the greatest use to transport and to the community.

* * * *

It is impossible here to trace the development of electrical science from the experiments described by Gilbert in 1600 to the equipment of electric locomotives on the railways of Switzerland and the United States of America. If we were able to trace this development we should see that it has been, not only a gradual, but a continuous and ordered increase of knowledge of natural phenomena. One must mention, however, what a change electrical traction by train and tube has made to our town life. It has rendered our large towns possible and given a chance to millions of our workers of a wider outlook on life and the opportunity of living amongst healthier and more pleasant surroundings. This is not the result of a sudden discovery of some fundamental principle, but is due to a studied advance, step by step, from very elementary knowledge to the information we have available and at our disposal to-day. This is very largely the result of endless laboratory research and experiment.

The last method of propulsion that I can deal with is that by means of the internal combustion engine, but it has not been largely used for rail transport owing to its comparatively high cost of fuel per horse-power and its lack of flexibility. The latter is particularly the case when one remembers the high torque which is so desirable, and which can be attained in both the steam and electric locomotives in starting.

Of transport by road it may be said that its commercial inception came at a time when scientific knowledge was well advanced, and its progress was in consequence more rapid. It must not be forgotten that in the fairly early part of last century considerable work was done on scientific lines with steam cars, only to be abandoned when legislation made its continuance impossible. The development of the motor car engine from the small unit of Daimler to the present car is undeniably due to the use of "ordered knowledge" of the gaseous mixture, of its ignition, of the fuel itself, and of the compression that should be employed. Here again we have a case of the careful application of the principle developed with ever-increasing care until we get engines as noiseless, as efficient, as reliable, and as flexible as we have them to-day. It is a case, too, where the development is so recent that many of us can remember the scorn and distrust that this method of traction excited even here in this city that was so prominent in its inception twenty-five years ago.

Very much more could be said as to the indebtedness of aeronautics to science, but the fact that this indebtedness is so self-evident, as well as the question of space at my disposal to deal with a subject of such a size, make it impossible to attempt to do justice to this part of my subject. Step by step investigations have led towards the perfecting of this type of transport. In all cases the developments have followed carefuls cientific research. It is impossible to touch more than in the lightest possible manner on the developments which have taken place in aeronautics due to scientific work. In the means of propulsion research nas given an engine of such size and so light in weight per horse-power that what was a laboured struggle against the effects of gravity has changed into the ability to rise at considerably over 1000ft. per minute to heights where the rarefaction of the atmosphere renders it necessary for oxygen for breathing to be obtained artificially. There is no greater instance of the indebtedness of transport to science than the rapidity with which the possibilities of transport by air have advanced. That the realities have not advanced at the same rate is due to financial reasons. As a rule we have a close relationship between these two, but in this instance, owing to the demands of war, this has not been the case, for we have the knowledge before we are financially able to use it to the greatest advantage. The change which has come about has been as largely due to the advances made in metallurgy as to the inventions in mechanics that have led to the improvements in means of propulsion and in machinery. It has very truly been said that every great metallurgical discovery has led to a rapid advance in other directions. I will, as before, deal with the railway as an example. We can hardly appreciate at this date the conditions which existed from a metallurgical standpoint on our railways when our first meeting at Liverpool was held in 1837. Iron—made laboriously, heterogeneous in character and expensive of production, not only in money, but, owing to the heavy character of the methods employed, detrimental to the very character of the workman—was the only material available. Remember for a moment that this was not only the material employed for the various parts of the mechanism of the locomotive, but for the rails. However improved the methods of manufacture were, there could never have been a universal development of rail

* Presidential address to Section G, British Association.—Abridged.

traction if it had depended upon material made in such a way. Another investigation which has given great results in transport has been the ever-growing use of alloy steels. For the scientific inception of these we owe a great debt to Sir Robert Hadfield, whose inventive genius and scientific mind are still active in that field he has made so particularly his own. His first investigations materially affect transport to-day. From these early uses of alloy steels there has grown up a large number of various alloys, many of which are of the very greatest use for various transport purposes. It is not too much to say that the modern aeroplane is the result of the material now at the designers' disposal both for the engine and for the structure itself. The strength of some of the chrome-nickel steels, combined with their ductility, is extraordinary, and is due not only to the composition of the metal, but to the results which have been obtained by patient scientific investigations relating to their heat treatment. It is not only with steels that we have been benefited so much from research. The case is as marked with light alloys, which have aluminium as a base. The latter itself is the result of investigation along scientific lines, and in aeronautical work particularly much has been done towards giving a metal both light and strong by the work of Walter Rosenhain, F. C. Lea, and others.

It may be said that all I have dealt with up to the present has been the result of special investigation, and that "ordered knowledge" is not of assistance to an everyday engineer such as myself. I may perhaps be forgiven if I refer to some personal work where the collection of that knowledge with the assistance of my colleagues, especially L. Archbutt and H. A. Treadgold, has been of great assistance to that large transport institution, the Midland Railway, with which we were so long associated. I have dealt briefly with the subject in a general way in a paper I read a little while ago before the Institution of Locomotive Engineers,* but would like to speak of it in more detail and in view of the fresh information that is now available. I would first speak of the results obtained with solid locomotive crank axles. Here we have a large mass of metal which in the rough state weighs about 40 cwt. It is forged from the ingot into a block about 25in. by 18in. in section, and this is then worked down at the two ends and in the middle to about 11in. in diameter, the pieces of the original section of the block remaining being the throws, which are twisted to an angle of 90 deg. to each other. A block about 1¼in. thick is slotted out of each web, and from these the tests to which the crank is subjected are taken. Sometimes a crank has to be taken out of service owing to the journal wearing down below a diameter at which it is judged safe for them to run, but more often flaws are developed which, however, are progressive, and with ordinary examination can be detected before any risk is taken in running. A crank axle is an expensive portion of a locomotive, and its replacement is not only costly, but takes a considerable amount of time, as the driving wheels have to be removed and replaced. These considerations have led us to give a good deal of attention to this piece of mechanism on what we believe to be scientific lines. Careful note has been taken, not only of the mechanical tests made on the portion removed from the throws, but of the microstructure of the metal itself. The first question which rises in our mind is why the cranks develop flaws at all. It is, of course, known that with ordinary structures one is able to calculate the stresses in them, but this is not so with a locomotive crank axle. Not only is it being subjected to the stresses set up by revolving it while it is loaded with the weight of a portion of the locomotive on its axle bearings and by the steam pressure on the pistons transmitted to the crank pins, but it has to withstand the shocks set up by its running on the rails, which cannot be calculated. These include the pressure set up on the edge of the wheels when entering a curve at a speed other than that which the super-elevation is allowed for, running over uneven rail joints and crossings, and also what I believe is one of the worst, if infrequent, the striking of check rails. These stresses and the resultants of them are most severe at the corners of the crank pins and at the radii where the webs or throws join the rounded portions of the axle. These are the points at which flaws usually occur.

For about twenty years we have endeavoured to get the knowledge we have obtained into an ordered state, from observation and discussion with the metallurgists attached to the various manufacturing firms. Certain points are obvious, such as the necessity of a good micro-structure, and whilst the details in connection with exactly what micro-structure is the best are somewhat uncertain and open to debate, we can with confidence say that the steel "shall be as free as possible from non-metallic enclosures, and that the micro-structure should show uniformly distributed pearlite in a sorbitic or very finely granular or lamellar condition and be free from any nodular or balled-up cementite. It must also be free from any signs of segregation and from any coarse or overheated structure" (extract from Midland Railway specification for crank axle forgings). The dimensions I have given of the size of the block of metal from which the axle is made show that it cannot have received much work, and therefore any non-metallic enclosures present will be only slightly drawn out, and will not occur as threads as they do in bars of small diameter and even in steel tires. One of the first observations we deduced was that the life of the crank in miles had a direct relation to the ductility of the test bar taken across the section of the throw and near the centre of the original ingot. This is the point at which non-metallic enclosures are most likely to be found, as well as that at which the greatest stress occurs. The inference is obvious that a flaw is likely to develop at some sharp corner of such an enclosure. In a section of steel such as that which must be used non-metallic enclosures are very likely to occur, and so steps had to be taken to ascertain what the best practical remedy was. With decreased carbon content greater ductility was likely to follow, and this has been shown to be the case. In a word, it is toughness rather than strength which is required, and the studied consideration of these points has led to an increased life in miles of the crank axles of the 3000 locomotives owned by the company, in spite of the fact that they have been constantly growing in size, in pressure on the pistons, and in the work expected from them.

It will be appreciated that the above result, which is unquestionably the result of "ordered knowledge of natural phenomena and the relation between them," is only one example, if perhaps the most marked one, in our experience. A somewhat similar one could, however, be written on locomotive tires and other matters if space and time permitted.

This example finishes my general remarks, and I cannot do so without expressing the indebtedness I feel to the various members of the scientific staff of our great firms for all the assistance and help they have ever so readily given us in the case I have just quoted.

One would like to press home strongly on engineers generally a point made by Dr. Maw in his presidential address to the Institution of Civil Engineers in November last. He pointed out the large amount of scientific knowledge—much of which was accumulated during the war—which is available at the present day. Here is the knowledge if we will but apply it to the service of man. This is our function as engineers. In times past we have had to wait for this knowledge, and, as I trust I have shown, as it slowly became available it has been used in our service and in that of the world. One great need is for men with the education, the capacity, and the imagination necessary to use this scientific knowledge for the advancement of our profession. I use these three requisites advisedly, for each one of them is necessary to take full advantage of the opportunities which now exist. The trouble is that whereas we can supply education, can increase the capacity of the individual, it is difficult to instil or cultivate that imagination which allows one to see the way in which the knowledge available can be applied in a practical way.

I would like, in closing, to make an appeal for a freer disclosure of results obtained in practical working. This can only be done by taking care in noting the behaviour of apparatus, material, &c., in use, and placing the results freely at the disposal of the man of science and of the manufacturers. At the present day there is no lack of those who are trained observers, and I believe one of the troubles often encountered by manufacturers who are applying some new method is the difficulty of getting dependable figures of performance. With transport companies this should not be a difficult matter, for one great advantage they have now is that there is no trade necessity to hide their results in any way. It is one small way in which they can repay the great debt they owe to science, which has allowed them to complete so satisfactorily their task.

* Inst. of Loco. Engineers, Vol. XII., 1921.

Restored Patents.

IN order that a patent may be kept in force renewal fees have to be paid every year after the expiry of the first four years from the date of the patent. An extension of time can be secured for paying these fees, but if this were exceeded even by a day, prior to the Patent Act of 1919, the patent became void and of no effect.

After the passing of that Act power was given to the Comptroller to restore a patent if it were proved to his satisfaction that the patentee intended to pay the fee for the purpose of keeping the patent in force but by inadvertence the fee was not paid.

This provision for the restoration of a patent has been invoked many times, and a large number of patents have been restored. The Act does not provide any time limit within which such application for restoration should be made, so that difficulty arises in this respect. In any particular art manufacturers may watch for the lapsing of a patent to enable them either to use it or to place on the market constructions of their own which might conceivably infringe it were it in force.

After the Act of 1919, therefore, one could not tell whether a patent marked in the Patent Office registers as void might possibly be restored or not.

The law which gave the Comptroller power to restore a patent also provided that in the restored grant some provision should be made for the protection of those persons who began to take advantage of the lapsing of the patent as they were entitled to do between the date of its lapsing and the date of restoration. The Comptroller has made Rules under the Act, those governing the matter being Rules 62 and 63 of the Patents Rules, 1920, Statutory Rules and Orders, 1920, No. 338.

It is not known to all inventors that in all cases of restored patents what is practically the new grant is limited. In other words, the restoration is only granted subject to these Rules. In cases where this is known it is not always appreciated what the Rules cover, because they are drafted in considerable detail, and, apparently, there is no case decided by the courts and reported in the official reports thoroughly explaining the matter.

It is useful, therefore, to set out, first, the two Rules exactly as they stand, and then to add a few notes in respect of them. Rule 62 provides thus :—

In every Order of the Comptroller restoring a patent provisions shall be inserted for the protection of persons who may have availed themselves of the subject-matter of the patent after the patent has been announced as void in the *Journal*. Such provisions shall restrain the patentee from commencing or prosecuting any action or other proceeding, and from recovering any damage :

(1) In respect of any infringement of the patent which shall have taken place after the date on which the patent was announced in the *Journal* to be void and before the date of the order.

(2) In respect of the use or employment at any time thereafter of any mechanism, machine, machinery, process or operation actually made or carried on within the United Kingdom, or of the use, purchase, or sale of any article manufactured or made in infringement of the patent after the date of the said announcement and before the date of the order. Provided that such use, purchase, sale or employment is by the person or corporation by or for whom such machine or machinery or article was *bonâ fide* manufactured or made, or such mechanism, machine, machinery, process or operation was *bonâ fide* made or carried on, his or their executors, administrators, successors, or vendees or his or their assigns respectively.

(3) In respect of the use, employment, or sale at any time thereafter by any person or corporation entitled for the time being under the preceding paragraph to use or employ any machine, machinery, mechanism, process, or operation of any improved or additional machine, machinery, mechanism, process or operation, or of the use or sale of any article manufactured or made by any of the means aforesaid in infringement of the patent ; provided that the use or employment of any such improved or additional machine, machinery, mechanism, process, or operation shall be limited to the buildings, works, or premises existing at the time being or afterwards erected of the person or corporation by or for whom such machine, machinery, mechanism, process, or operation was made or carried on within the meaning of the preceding paragraph, his or their executors, administrators, successors or assigns.

Rule 63 provides :—

The order shall further provide that if any person within one year after the date thereof make an application to the Board for compensation in respect of money, time, or labour expended by the applicant upon the subject-matter of the patent in the *bonâ fide* belief that such patent had become and continued to be void, it shall be lawful for the Board, after hearing the parties concerned, or their agents, to assess the amount of such compensation if, in their opinion, the application ought to be granted, and to specify the party by whom and the day on which such compensation shall be paid, and if default shall be made in payment of the sum awarded, then the said patent shall become void, but the sum awarded shall not in that case be recoverable as a debt or damages.

As to Rule 62, the first section deals with infringements committed when the patent was void and frees them.

As apparatus made in the void period and freed under Sec. 1 might constitute an infringement if used after the patent had been restored. Sec. 2 deals with the employment of such apparatus and the like at any time after the date of restoration and more specifically provides for the persons entitled to such use. Sec. 3 introduces a limitation in respect of Sec. 2, in that it starts with the assumption that certain persons are entitled to use the subject of the patent and then defines where the user may be conducted.

Rule 63 is more clear than Rule 62, and provides for the payment of compensation under the circumstances therein mentioned.

BOOKS RECEIVED.

Friction. By T. E. Stanton. London : Longmans, Green and Co., 39, Paternoster-row, E.C. 4. Price 12s. 6d.

Bureau Bulletin of the British Cast Iron Research Association. Birmingham : Offices of the Association, 75, New-street.

Laminated Springs. By T. H. Sanders. London : The Locomotive Publishing Company, 3, Amen-corner, E.C. 4. Price 25s. net.

Railways for All. By J. F. Gairns. London : Ward, Lock and Co., Limited, Warwick House, Salisbury-square, E.C. 4. Price 6s. net.

Silica in Canada. Its Occurrence, Exploitation, and Uses. Part I. : Eastern Canada. By L. Heber Cole. Ottawa : Government Printing Bureau, 1923.

Lighting Circuits and Switches. By Terrell Croft. London : McGraw Hill Publishing Company, 6 and 8, Bouverie-street, E.C. 4. Price 15s. net.

Electrical Measuring Instruments and Supply Meters. By D. J. Bolton. London : Chapman and Hall, Limited, 11, Henrietta-street, W.C. 2. Price 12s. 6d. net.

Elements of Graphic Statics. By Clarence W. Hudson and Edward J. Squire. London : The McGraw Hill Publishing Company, Limited, 6 and 8, Bouverie-street, E.C. 4. Price 6s. 3d. net.

The British Acetylene and Welding Handbook. Prepared by a Committee of the British Acetylene and Welding Association. London : *The Acetylene and Welding Journal*, 30, Red Lion-square, W.C. 1. Price 7s. 6d. net.

THE output of nickel in Ontario for the first half of 1923 totalled 27,000,000 lb., valued at 8,427,000 dollars, as compared with 4,000,000 lb. valued at 1,401,000 dollars for the first half of 1922.

Electricity in Mines.

No. IX.*

A CONSIDERABLE amount of ingenuity has been brought to bear upon the design of switchgear for use in mines, and many switchgear firms specialise in this class of work. The mining switchgear built by Ferguson Pailin, Limited, of Higher Openshaw, Manchester, is of the air-break and oil-break types, and is built on the sectional principle, which enables single-unit or multiple-unit switchboards to be built up to suit requirements. The method of construction and combination of units make units or complete switchboards dust and flame-proof, and all "live" parts are totally enclosed, thus preventing accidental contact, open arcing, &c. Both types of apparatus are suitable for various classes of work. The air-break type, comprising air-break switches, fuses, &c., is suitable for pressure up to 660 volts, and for currents up to 200 ampères, whilst the oil-break type may be further sectionalised. The firm's type A switch is for currents up to 350 ampères at 660 volts; the type B switch for currents up to 250 ampères at 660 volts, and 200 ampères at 3300 volts; and the type C switch will deal with currents up to 750 ampères at 660 volts, 400 ampères at 3300 volts, and 200 ampères at 6600 volts. Massive construction is the main feature of the design. The provision of wide metal machined flanges and a correctly proportioned relief aperture makes the apparatus flame-proof, and ensures that the escaping gases are sufficiently cooled before passing into the surrounding atmosphere. The switch parts of the air-break type gear are mounted on bakelite insulation, and fitted with insulating separators between poles. The connections are at the front of the switch, and the leads are brought in through sealing boxes at the top and bottom of the enclosing case. The switches and fuses are of robust construction. An interlock is provided on each unit between the switch handle and the door of the case, so that the operator cannot touch the switches or fuses until the switch is in the "off" position.

All oil-immersed switchgear is constructed so that all arcing due to breaking the main current occurs under oil, thus eliminating any possibility of igniting inflammable gases, coal dust, &c. Arrangements have also been made on all the oil-immersed switchgear for the provision of the usual automatic releases. In addition to overload and no-voltage attachments, a leakage current tripping device may be provided, which acts as a further protection. Inverse time-limit attachments of the dashpot type can be fitted to work in conjunction with the overload coils, so that any overload of short duration will not trip the breaker. A loose handle arrangement can be provided, which, acting in conjunction with the overload trip coils, prevents the breaker being completely closed on a fault. The company's oil-immersed circuit breaker shown in Fig. 52 can be supplied as a main breaker in sizes up to 350 ampères, but it has

* No. VIII. appeared September 14th.

rotary movement is imparted through link mechanism. Both contacts are of the finger type, and a high operating speed is obtained by means of accelerating springs. The circuit is also quickly closed. By the provision of isolating switches it is possible to make the breaker "dead" and to make adjustments without interrupting the supply. A system of mechanical interlocks prevents the isolating switch from being operated when the breaker is closed.

Other switches are as stated designated types B and C, the latter being larger than the former. These switches can be made up into a multiple-unit switchboard—as shown in Fig. 55—and each type of switch can be of the draw-out or stationary pattern. The illustrations, Figs. 53 and 54, shown a B type stationary and draw-out unit respectively. Bakelite insulation has been used throughout. The terminals, which are composed of hard-drawn high-conductivity copper rod, are passed through the breaker base, and carry the fixed contacts at their lower ends, which comprise substantial copper blocks. The moving brushes are carried by a bakelite insulated bar of square cross section, to which they are clamped, the bar being connected to the lever gear through steel links. The brushes are composed of thin copper laminæ, which are bolted between phosphor bronze stiffeners. Arcing contacts are fitted, and are mounted on a copper frame immediately behind the main brushes. A high breaking speed is obtained by the throw "off" effect of the brushes and by the provision of strong accelerating springs. Arrangements can be made on both this and the type C circuit breaker for mounting buffer resistances, which are recommended for high-tension motors, converters and transformers of 250-kilowatt capacity and upwards. Current transformers of the compound insulated ring type can be provided, together with oil-immersed potential transformers, capable of operating the usual indicating or integrating instruments employed on such circuits.

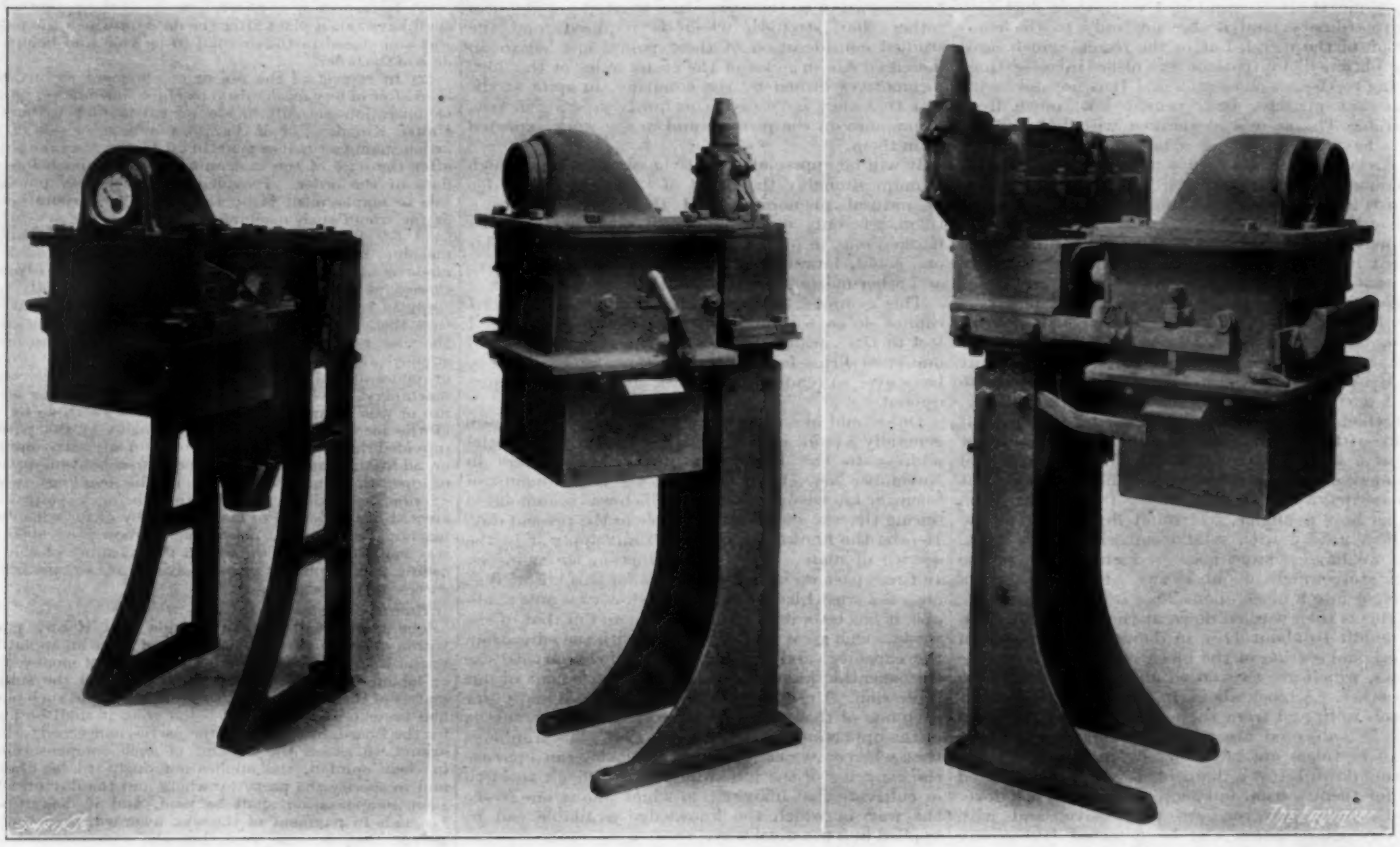

FIG. 52—OIL-IMMERSED CIRCUIT BREAKER FIG. 53—STATIONARY TYPE SWITCH FIG. 54—DRAW-OUT SWITCH

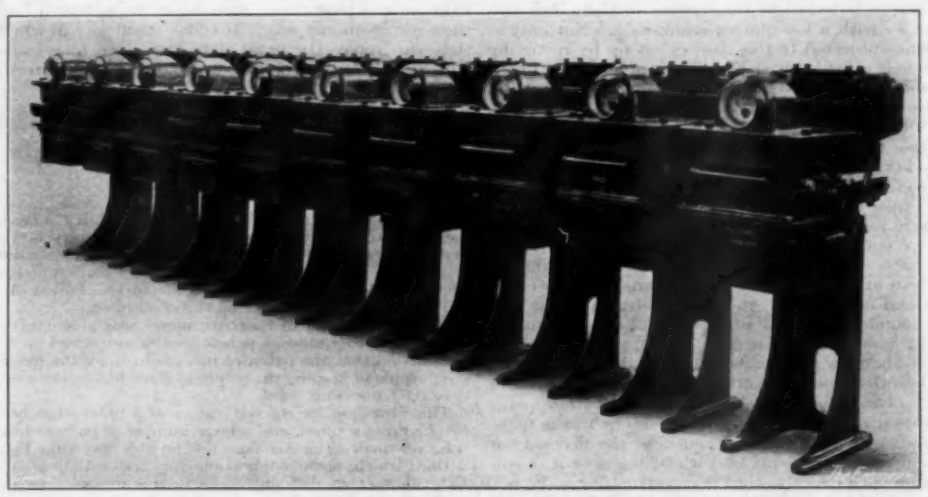

FIG. 55—MULTIPLE UNIT SWITCHBOARD

The potential transformers are connected to the side of the breaker remote from the incoming supply and mounted on a rigid supporting structure beneath the moving brushes. These transformers are protected on the high-tension side by oil-immersed fuses, which are easily accessible for renewal when the breaker tank is lowered.

The draw-out units consist of two elements—a stationary section, containing the bus-bars and cable terminal boxes, and a moving section, consisting of a carriage type oil-immersed circuit breaker and instrument transformers, &c. A massive cast iron pedestal

forms the main structural frame supporting the whole of the equipment, thus making it a self-contained unit. Two wide upper surfaces of substantial machined strapping, form the rails on which the rollers of the circuit breaker carriage ride. The bus-bars are enclosed in a substantial chamber at the top of the pedestal. Both the isolating plugs and receptacles are supported in bakelite bushing type insulators, and a large area of contact is obtained. Care has to be exercised with draw-out gear in order to ensure correct sequence of operation, and a complete set of mechanical interlocks is provided which make this apparatus as fool-proof as possible. The circuit breaker can be locked in position so as to prevent its withdrawal by unauthorised persons. Stops are also provided to prevent the circuit breaker carriage being withdrawn too far. A substantial shutter may be bolted over the live receptacles with a view to preventing personal contact being made, and it is possible to bolt this in position without lifting the breaker off the rails. The moving section cannot be inserted into the stationary portion unless the breaker is in the "off" position and the tank is properly fitted. Furthermore, the tank cannot be lowered with the breaker in the "on" position. For the heavier sizes of the C type breaker an ingenious ratchet lever gear is provided, which permits of easy insertion or withdrawal of the moving elements, and a mechanical device indicates the "on" and "off" position of the breaker. Many uses can be made with the no-volt attachment fitted to these breakers. Leads can be brought out to an auxiliary switch some distance away, this giving remote electrical control of the breakers. It may also be used as an interlock between an induction motor starter and the breaker, thus preventing the latter being put into the "on" position before the starter is brought back into its starting position.

The flame-proof gate end box, shown in Fig. 56, has

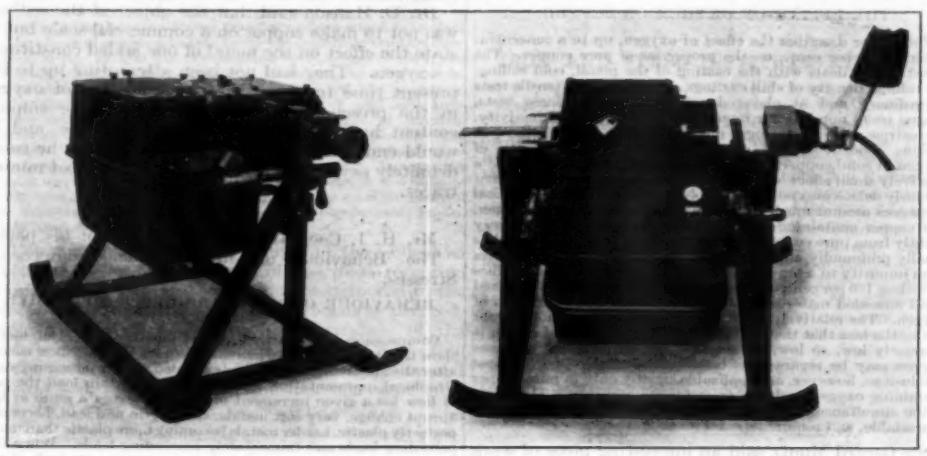

FIG. 56—FLAME-PROOF GATE END BOX

FIG. 57—BOX WITH PLUG REMOVED

been designed to withstand rough usage, and its weight is distributed to facilitate its movement from one part of the coal face to another, special runners being supplied for this purpose. The breaker is oil immersed, and exactly similar in construction to the type A unit already described. All the special features of that unit are retained, such as the provision of overload and no-volt releases, time lags, &c., with an additional draw-out arrangement. The main supporting frame consists of a rigid self-supporting angle and flat iron structure, upon which the circuit breaker is securely bolted. The circuit breaker is the stationary portion and the plug box at the rear is the moving element. This plug box is supported on long steel guide rods, which engage in two supporting bearings fitted to each side of the main stationary structure and permit the insertion or withdrawal of the plug box, as desired. The provision of adequate interlocks make the unit as fool-proof as possible, and provides the following advantages:—The plug box cannot be withdrawn or inserted into the stationary portion with the circuit breaker in the "on" position. The connecting plugs cannot be inserted into or withdrawn from the plug box with the breaker in the "on" position. The tank cannot be removed with the breaker in the "on" position. A loose handle arrangement can be provided, which, operating in conjunction with overload release coils, prevents the breaker from being completely closed on a fault. The plug box cannot be withdrawn too far, and when withdrawn a substantial shield can be bolted down for screening the live parts. The illustration, Fig. 57, shows the plug box withdrawn and the padlock, which locks the shield, in position. This prevents unauthorised operation and makes personal contact impossible. The plug fitted to the trailing cable is substantially constructed, and the plug and socket device ensures good contact. All the mining apparatus described can be supplied for use in non-fiery mines, the wide flange joints being then replaced by well-packed joints.

The Institute of Metals.

No. II.*

THE reading and discussion of papers was resumed at the Municipal College of Technology on the morning of September 11th before a good attendance. Mr. Leonard Sumner (President) occupied the chair.

The first paper taken was by Miss Marie L. V. Gayler, "The Constitution and Age-hardening of the Quarternary Alloys of Aluminium, Copper, Magnesium, and Magnesium Silicide." A brief *précis* of this paper is given below.

CONSTITUTION AND AGE-HARDENING OF QUATERNARY ALLOYS.

In a quaternary system it is only possible to represent the equilibrium of the system at any single temperature, and the isothermal sections take the form of regular tetrahedra. For this investigation isotherms at 400 deg. Cent. and 250 deg. Cent. have been determined from the results of thermal and microscopic examination, and wire models have been constructed. The results show that when copper, magnesium and magnesium silicide are present in aluminium, any two of these components have a marked effect on the solubility of the third. The sum of these effects is that ultimately $CuAl_2$ and Mg_2Si are both thrown out of solution. Also, if copper and magnesium are present in a ratio greater than 12 to 5 approximately, then alloys when quenched from high temperatures age-harden at room temperature, owing to the difference in the solubility of Mg_2Si at the quenching and ageing temperature. If, however, the ratio of copper to magnesium is less than 12 to 5, then no age-hardening takes place, since there is little difference in the solubility of Mg_2Si at high and low temperatures. The slight increase in hardness obtained on further heat treating these quenched and aged alloys is attributed to the small difference in solubility of copper at the quenching and ageing temperature. It is shown, therefore, that the age-hardening of alloys of the "duralumin" type is due primarily to Mg_2Si, copper causing very little age-hardening, and that the addition of magnesium and copper is important, since both reduce the solubility of Mg_2Si at high and low temperatures and consequently reduce the maximum age-hardness due to Mg_2Si.

Dr. Walter Rosenhain asked members of the Institute to remember that, although this might appear to be a piece of purely academic work, it was of considerable practical importance. Its importance was of a two-fold character; it was the beginning of a task which would have to be faced in the near future, which involved the study of quartenary systems. Many of the alloys used in industrial practice were quarternary alloys, and it was obvious that a knowledge of binary alloys was only a step in the direction of a fuller knowledge of quarternary systems. Useful work was now being done. The persistent study of the constitution of aluminium alloys had lead to an insight into the mechanism which governed the physical properties of these alloys, which was greater than that which had been acquired in connection with any other alloys, known or used, not excepting steel. The knowledge which had been gained of the age-hardening process had lead to the production of important alloys for industrial requirements, of which a notable example was the "Y" alloy. As a result of research work it had been found possible to raise the tensile strength figure of that alloy to 31 tons, an achievement due to the success which had been met with in bringing out the hardening effect not only of the magnesium but of the copper content. The end of what might be accomplished in that direction had not yet been reached, but it was clear that important practical results could be achieved.

Mr. J. L. Haughton said the paper was of an epoch-making character, and was bound to arouse general interest. He had his doubts as to the wisdom of choosing the particular components selected for the research, but probably the reason for the choice made by the author was that magnesium sulphide played so important a part in the age hardening. Personally he thought the work would have been simplified by using silicon as the fourth component.

Miss Gayler, in replying to the discussion, said she had anticipated the query raised by Mr. Haughton, but magnesium sulphide had been selected because it was desired to show clearly that that constituent was the predominant partner in the system.

A long discussion followed the reading of the paper, of which an abstract follows, by Mr. Ulick R. Evans on "The Electro-chemical Character of Corrosion."

CORROSION.

Experiments are described which indicate that the corrosion of metals is mainly—probably entirely—electro-chemical in character. There are two main types. The type accompanied by evolution of hydrogen gas is characteristic of reactive metals placed in acid solutions, but the velocity varies greatly with the degree of purity of the metal. When this type is impossible slower corrosion can take place at a rate determined by the diffusion of oxygen to the metal, and is comparatively independent of the purity. When a metal is immersed in a solution of potassium chloride, one can observe the production of alkali at the cathodic portions, the production of the chloride of the metal at the anodic portions, and the precipitation of hydroxide where these meet. The electric current can be trapped and measured, and is found, by applying Faraday's law, to account for the greater part of the corrosion actually observed. Generally the cathodic areas are those to which air has free access, whilst the anodic areas are those protected from aeration. It is significant that corrosion usually proceeds most rapidly at the comparatively "unaerated" places; hence the intense corrosion observed in "pits" and over areas covered up by porous corrosion products.

Dr. Guy D. Bengough said he thoroughly disagreed with a large part of the paper while welcoming the contribution to the literature of the subject, and as bringing into sharp relief two opposing points of view from the discussion of which a certain measure of truth was bound to emerge. The author claimed that the observed phenomena of corrosion corresponded closely to those which would be predicted from fundamental electro-chemical principles, but there were a number of cases which showed that the simple electro-chemical interpretation adopted by Mr. Evans was not sufficient in itself. Mr. Evans admitted that the formation of oxide scales on metal retarded corrosion on his theory. That was really a very important aspect of the corrosion problem. It was known that aluminium and many other metals behaved quite differently from what would be expected from Table I. of the paper, the figures in which were obtained under special conditions. Mr. Evans referred to the views expressed in the sixth report to the Corrosion Committee, that there was not sufficient evidence of the intermediate production of hydrogen in the corrosion of metals, such as copper and zinc, and its subsequent oxidation. He—Dr. Bengough—was prepared to admit that the first action of corrosion in the case of many metals might be the displacement of hydrogen, and to modify his views to that extent. He must challenge the statement of Mr. Evans that the rate of corrosion would be nearly independent of the state of purity of the metal because the maximum rate of corrosion was fixed by the rate of diffusion of oxygen across the layer next to the metallic surface, and that rate of diffusion was not affected by the amount of impurity. That reasoning was unsound because the rate of corrosion was dependent on the total amount of oxygen reaching the cathode and the amount depended not only on the rate of diffusion of oxygen but also on the area of the cathode. There was another important point. In the two experiments described by the author on page 25 of his paper, it was found that 61 per cent. and 59 per cent. of the total corrosion might be accounted for by the external current measured simultaneously. There was thus a balance of 40 per cent. on an average of two experiments which was unaccounted for by the current measured. As the object of the experiment was to discover whether the whole of the action was electro-chemical or not, the figures were significant. The author claimed, however, that that 40 per cent. of corrosion was also electro-chemical. It seemed to him that the author had misinterpreted his own experiments. Throughout a great part of his paper the author attached far too great importance to the oxygen concentration cell effect. A more important factor in his opinion, and one which was postulated as a cause of pitting in the sixth report to the Corrosion Committee, was the presence of differences of metal ion concentration over the metallic surfaces. If the scale contained metal ions in close proximity to the metallic surface then erosion of the scale would also remove the metal ions over the eroded area. For those and other reasons he emphasised the opinion of those engaged in the experimental work of the Corrosion Committee, that corrosion was greater where the access of oxygen to the actual metal surface was greatest and not where the access was least, as the author asserted. Mr. Evans claimed to have proved four facts which he set out on page 40 of his paper. The Corrosion Committee had reached those conclusions long since, and had set them out in the sixth report. It was there stated that experimental evidence indicated a small amount of electro-chemical action in corrosion; that one of the most important causes of pitting was concentration cell action, a purely electro-chemical phenomenon; and that electro-chemical action predominated in the corrosion of couples, the metals of which corroded in a manner different from that of the separated metals. The real point to be determined was whether the whole action could be accounted for on the electro-chemical theory, and in no case had Mr. Evans succeeded in proving that to be the case. The author brought forward an alleged difficulty in connection with the colloid theory of corrosion, but on

* No. I. appeared September 14th.

that point the difference between Mr. Evans and those who were working on the subject in other directions was confined to the different views adopted regarding the accessibility of oxygen to the metallic surface. Although he rejected the view that colloid might play an important point in the early stages of corrosion, Mr. Evans did not put forward any alternative theory which could adequately explain certain results which had been reached.

Mr. J. McArthur Stuart expressed the view that the author had constructed a theory of corrosion which was only simple and plausible if a large range of corrosion phenomena were excluded from consideration. As a useful general working hypothesis it was quite inadequate. Mr. Evans had studied only the very early stages of corrosion, his quantitative work had been carried out for too short a period, and he had not taken into account certain phenomena which at a later stage of corrosion became of predominating importance. The weight of evidence was against the theory that all corrosion was electro-chemical in type. Mr. Evans' experiments had been so arranged as to emphasise certain minor and ephemeral factors; he had not attempted to study the really important factors which dictated the amount and distribution of corrosion in many conditions met with in practice, of which the distribution of corrosion products was an outstanding example. Some corrosion was certainly electro-chemical in type, but no evidence had been produced that all corrosion was electro-chemical and the theory could not be accepted.

Mr. F. de Wurstemberger thought that the experiments described in the paper gave proof of the existence of a general law. The paper raised once more the controversy between the chemical and electro-chemical schools of thought, and until the dispute was settled progress in the prevention of corrosion would be hampered. Under certain working conditions large areas of the metal surfaces acquired a more noble potential than others, and became cathodes which endangered other parts of the metallic surface where the same change had not taken place. The protective measures on that theory must accordingly be designed to affect the whole surface in such a way as to equalise the difference of potential. On the other hand, those who clung to the chemical theory regarded the matter from another standpoint and looked for means to prevent chemical action by cleaning processes and by the use of protective films without taking account of the electro-chemical character of the attack. Mr. Evans had clearly shown the effect of an aerated surface in producing electro-chemical action, and had made an attempt to indicate the measures which should be adopted to prevent corrosion. The whole question was one of great practical interest, and he hoped that the scientific research of the subject and the reconciling of opposed theories would proceed more rapidly.

Mr. W. H. J. Vernon agreed with those who thought that Mr. Evans had not proved his case. Without questioning the value of the work that had been done in connection with a large range of phenomena, it appeared to him that nothing short of mental gymnastics could make the theory that the whole action was electro-chemical fit the facts.

Mr. Evans, in a brief reply which will be extended by correspondence, said it remained unchallenged that electric current was produced. It was clear, therefore, that the action was essentially electro-chemical. No doubt metal ion concentration cells were set up, but the effect of those cells would be to oppose and not to produce corrosion. With regard to the criticism as to the shortness of time of his experiments, he recognised that in the later stages of corrosion the accumulation of corrosion products set up a disturbing factor. He had discussed the action of corrosion products in another paper. His object in this contribution was to deal with the fundamental causes of corrosion. He was glad to find that Dr. Bengough admitted that as much as 60 per cent. of the total corrosion was electro-chemical, or at least did not dispute that figure. On the last occasion when that subject was under discussion Dr. Bengough's views were that only about a thousandth part of the total was of an electro-chemical character. What happened to the remaining 40 per cent. it was not easy to say, but it was quite certain that if electro-chemical corrosion existed at all corrosion would be set up between one part of a plate and another, and that current would not pass through the ammeter and would not therefore be recorded. In the circumstances it was satisfactory to get 60 per cent. recorded. If Dr. Bengough wished to claim the 40 per cent. as due to chemical action, he was, having admitted so much on the electro-chemical side, entitled to that measure of consolation.

A paper was then read by Mr. Douglas H. Ingall on "Experiments with Some Copper Wire; Cohesion a Function of both Temperature and Cold Work."

EXPERIMENTS WITH COPPER WIRE.

Five samples of copper wire were used representing soft annealed and four degrees of cold work given by 25, 40, 50, and 75 per cent. reduction of area by drawing. Each sample of cold-worked wire was obtained by drawing in one pass from the next thicker wire. The cohesion at elevated temperatures was determined by placing given loads on the wire at atmospheric temperature, heating the wire and determining the temperature at which it broke. All the samples gave similar graphs—plotting cohesion against temperature—in which with rise of temperature the cohesion decreased along a straight line to a constant critical temperature of 350 deg. Cent., beyond which the cohesion was represented by a sharply descending curve. The equations to the straight lines $C = a - bT$ and to the curves $T C^n = k$ (where C = cohesion and T = temperature) showed that the percentage increase of the constant b and the percentage decrease of the constant n were represented by the corresponding percentage reductions for any given cold-worked wire, with the exception of constant n in the 75 per cent. reduced wire. Fractures above the critical inflection temperature of 350 deg. Cent. were brittle in character and intergranular; at the lower temperatures they were normal. At the critical inflection temperature the material was comparatively extremely fragile.

Opening the discussion, Dr. S. Johnson congratulated the author on having taken up a method of investigation which gave great promise of yielding useful results. He would suggest that a further experiment should be made with copper wire to determine the amount of oxygen.

Mr. T. G. Bamford said the author had brought out an important and useful method of calculating the strength at high temperatures of specimens which had been worked, and if his method was generally adopted it ought to be possible to say at different temperatures for a given degree of work what the strength of the material would be. Attempts had been made on previous occasions to obtain similar information; one method was to determine the resistance to distortion at different temperatures which gave useful results; another was to measure the cohesion of the metal at different temperatures. He hoped that the work would go on as an interesting field of investigation had certainly been opened up.

Mr. Ingall, in closing the discussion, expressed regret that he had not been able to determine the oxygen content of the material analytically before the paper was printed. He was much interested in the suggestions which had been made and would reply to some of the points in writing.

Miss Grace W. Ford gave a summary of the paper for which she, Dr. D. Hanson and Mr. C. Marryatt are the joint authors on "Investigation of the Effects of Impurities in Copper. Part I., The Effect of Oxygen on Copper."

THE EFFECT OF OXYGEN ON COPPER.

This paper describes the effect of oxygen, up to a concentration of 0.36 per cent., on the properties of pure copper. The investigation deals with the casting of the metal, cold rolling, hot rolling, density of chill castings and rolled bars, tensile tests at ordinary and at elevated temperatures, hardness tests, fatigue tests, notched-bar impact tests, electrical conductivity, microstructure of castings, microstructures of the alloys in various conditions, and determination of the solubility of oxygen in solid copper. The results indicate that oxygen has a relatively small effect on the properties of copper, and is neither seriously deleterious nor remarkably beneficial. The mechanical properties are not much affected by small quantities of oxygen, and copper containing as much as 0.1 per cent. differs very slightly from pure copper. The electrical conductivity, which is usually profoundly affected by the addition of small quantities of an impurity to a pure metal, does not fall rapidly, and values exceeding 100 per cent. of the international standard are obtained in all annealed materials containing less than 0.1 per cent. of oxygen. The relatively small effect of oxygen is without doubt due to the fact that the solubility of the oxide in solid copper is extremely low, so low, in fact, that for all practical purposes oxygen may be regarded as insoluble in solid copper. These conclusions, however, are applicable strictly only to pure copper containing oxygen and free from other impurities. The effect of the simultaneous presence of other impurities may be very appreciable, and requires special investigation.

Sir Gerard Muntz said an interesting piece of work had been carried out, but he was bound to say that, in comparison with the amount of money which had been spent, very little appeared to have been accomplished, and only the beginning of the research had been entered upon. He thought the work could have been shortened if those in charge of it had consulted those who had been engaged in the handling of copper for many years. In that case the early stages of the work might have been omitted. Pouring methods and speed were questions of instinct as well as experience. No amateur could learn to pour into a mould correctly without experience in works, and he was surprised that the experimenters had succeeded in getting any sound castings at all. A point of interest was the question of oxygen in pure copper. He had been investigating that subject for many years, but it had been research carried out for the works in which he was interested, and in the past, whatever might be the case at present, they had not given the results away. The oxygen content was very important from the point of view of the conductivity of the material, and an excess of oxygen had been found in practice to affect the working and quality of the copper and to cause cracks. When those engaged in the research began to deal with impurities and their effect manufacturers would begin to obtain the knowledge they required from that investigation. What was wanted was information as to the effect of oxygen, not on pure copper, but on commercial copper which contained, not much, perhaps, but a certain percentage of impurities.

Dr. Rosenhain said that Sir Gerard Muntz had had every opportunity to influence the plan of work, and his criticism was not, therefore, quite fair. It was in order to test the effect of various factors on behalf of the practical man that the investigation was started, and he thought it could be claimed that some information had been placed already at the disposal of the industry. It could also be stated that some of the research work carried out by manufacturers, the results of which had been kept as trade secrets, had not yielded accurate information. He thought it was a right and proper course in undertaking an investigation of this kind to begin at the beginning and not to make assumptions even at the earliest stages of the work. They had had the advantage of a considerable amount of information from Sir Gerard Muntz and other copper manufacturers, but they thought the object of the research would be better achieved if they began the whole thing *de novo*. The main objective was to ascertain the effects of different concentration of copper, and they obtained samples for the purposes of the work, which could not have been produced by ordinary methods of manufacture. Reference had been made to the impossibility of any amateur being able to acquire sufficient knowledge of pouring to do the work correctly, but he thought he was justified in claiming that any scientific worker could learn in a very short time to do a thing of that kind. If it had been desired to produce a constant product he would have come to Sir Gerard Muntz, but he thought that the research workers who were attacking the problem were quite capable of producing the different kind of castings which were required. Work on other impurities besides oxygen was now in hand and would be laid before the Institute at a later date.

Dr. F. Johnson was inclined to agree with the remarks of Sir Gerard Muntz. He thought, too, it was a mistake for research workers to ignore the knowledge which had been acquired previously, and not acknowledge the debt due to earlier workers in the same field. No reference had been made in the paper to what had been done in the United States by Hoffman and his collaborators. Nor did he think that work of this character need be necessarily confined to the precincts of the National Physical Laboratory, but that co-operation with other Institutions should be secured. With regard to the statement in the paper that oxygen up to .1 per cent. had no beneficial or harmful effect on copper that was not the experience of practical men. The chief function of the oxygen content was to enable the manufacturer to make good copper in the presence of detrimental impurities and to enable that copper to be worked. Another great advantage of oxygen was that it enabled annealing to be carried out more satisfactorily.

Dr. D. Hanson said that the object of the authors was not to make copper on a commercial scale but to state the effect on the metal of one added constituent—oxygen. They had not been attempting up to the present time to investigate the influence of oxygen in the presence of other impurities. The sulphur content had been looked for in every case, and he would endeavour to supply the figures, but he could definitely say that it was only present in most minute traces.

OTHER PAPERS.

Mr. H. I. Coe gave a brief abstract of his paper, "The Behaviour of Metals under Compressive Stresses."

BEHAVIOUR OF METALS UNDER COMPRESSIVE STRESSES.

Compression tests carried out on small cylinders of metals show that with successive increments of loads plastic flow occurs, after the elastic limit has been exceeded, at an increasing rate. Graphical representation shows that at a certain load the rate of flow for a given increment of load undergoes a more or less abrupt change, very soft metals, such as tin and lead, becoming perfectly plastic, harder metals becoming more plastic than under preceding loads and immediately succeeding loads. When this particular load is expressed as a stress per square inch of the enlarged section of the cylinder, it is found that the value obtained agrees very closely with the maximum load per square inch in tension of the same material. The term "critical plasticity" has been used to indicate the change in the rate of plastic deformation which most metals exhibit at a particular load. Annealed metals appear to commence flowing at a comparatively low load and continue doing so at an increasing rate up to the load corresponding to critical plasticity; the same metals, however, in the worked condition are much more resistant to compressive stresses until they approach near the load corresponding to critical plasticity, when they suddenly collapse and a marked temporary flow occurs.

Mr. T. H. Turner welcomed the contribution as suggesting a possible means of laying down a fundamental law on the subject.

The papers by Mr. Hugh O'Neill on "Hardness Tests on Crystals of Aluminium," and Messieurs A. M. Portevin and Pierre Chevenard on "A Dilatometric Study of the Transformations and Thermal Treatment of Light Alloys of Aluminium," and Professor P. Soldau on "Equilibrium in the System Gold-Zinc—based on Investigations of Electrical Conductivity at High Temperatures," were taken as read, and will be discussed by correspondence. Brief summaries of their contents follow.

HARDNESS TESTS ON CRYSTALS OF ALUMINIUM.

In the Brinell hardness test the relation between the applied load L and the diameter d of the indentation produced on a specimen is given by $L = a\,d^n$ (Mayer's formula). Many workers have determined the values of a and n for different metals, and the author has recently shown that for an amorphous substance $n = 2.0$. The present paper deals with completely crystalline material, single crystals of aluminium having been chosen since the technique of their production has been worked out by Professor Carpenter and Miss Elam. Two pieces of aluminium strip were treated separately by the Carpenter and Elam process, but only the first became a single cystal. By accident it was annealed for a short time just below its melting point and upon its upper surface three series of parallel ridged markings were visible. X-ray examination showed that this surface was a rhombic-dodecahedral (011) face, whilst two crystals chosen from the second piece proved likewise to be presenting octahedral (111) and cube (001) faces respectively. Brinell tests showed that at low loads the different crystallographic planes resist penetration to different degrees, and give indentations of different shapes. In the Brinell sense the 011 face is the "hardest" and the cube (001) face appears to be the "softest." The load required to give a Brinell impression equal in diameter to that of the ball—and probably eventually to make it perforate the metal—is apparently the same in all cases. Crystal boundaries were found to be without any appreciable effect in increasing the resistance of aluminium to penetration. In terms of Meyer's formula, if a 1 mm. ball be used, n varies from 2.483

for the 001 face to 2.274 for the 011 face, and a is a constant for annealed aluminium, independent of the presence of grain boundaries and, in single crystals, of grain orientation.

LIGHT ALLOYS OF ALUMINIUM.

Amongst the light alloys of aluminium—density less than 3—capable of being hardened by quenching followed by tempering is the group known under the name of duralumin, the essential characteristic of which is the magnesium content. The effect of the addition of this metal to commercial aluminium was first pointed out by Wilm, whose work was the starting point of the use in industry of quenched alloys containing magnesium and copper alloyed with aluminium, with or without the addition of other metals, such as manganese, zinc, &c. The investigations of Rosenhain, Archbutt, Hanson and Gayler have linked up the phenomena of quenching shown by these alloys, with the variation of the solubility, in solid aluminium, of the compound Mg_2Si formed between magnesium and the silicon which is always present in commercial aluminium. But the solubility curves of this definite compound Mg_2Si in solid aluminium have only been indirectly traced by the examination of alloys quenched at different temperatures, the transformations having hardly been studied, up till last year, by direct physical measurements, in particular by the investigation of thermal expansion. The very indistinctly marked points on the heating curves had only been observed in alloys which had been initially quenched or worked, but never on a specimen which was in the annealed state; in addition, they disappeared on cooling and on a second heating. After detailing fully their experimental work the authors conclude that the application of dilatometric methods, judiciously using the recording differential dilatometer, permits of the study of the transformations and the mechanism of heat treatment of the light alloys of aluminium-magnesium-silicon, and, in general, of alloys containing two-phase univarient transformations, a study of which had not been carried out up to the present. The study of the constant temperature transformations by the differential dilatometer, using a high sensitivity apparatus, leads to general expressions representing the phenomena as functions of time and temperature. The phenomena of quenching and tempering in the aluminium-magnesium-silicon alloys can be interpreted by the known variations in the solubility of Mg_2Si in the solid state, without it being necessary to assume any further transformations in these alloys.

EQUILIBRIUM IN THE GOLD-ZINC SYSTEM.

The alloys of gold and zinc belong to the type of A B brasses, where A is a metal belonging to the first and B to the second group of the periodic system. These alloys are of considerable practical importance, as their chemical nature is very close to the alloys of copper with zinc, *i.e.*, to the ordinary brasses, which, next to iron and steel, occupy the most prominent position in industry. It was to be expected, therefore, that the investigation of the nature of the alloys of gold and zinc would help to throw light on the complicated transformations which take place in the alloys of copper and zinc below their melting temperature. The gold-zinc system was investigated by R. Vogel in 1906, and no transformations were detected. However, the results of an investigation of the gold-cadmium system led the author to undertake the investigation of the alloys of gold and zinc, taking advantage of several different methods of physico-chemical analyses, which would check and supplement one another. Special attention was paid to the determination of electrical conductivity at high temperatures. Among the results arrived at was the disproval of the existence of a definite compound Au_2Zn_3 mentioned by Vogel and the establishment of the existence of three definite gold-zinc compounds Au_3Zn, $AuZn$, and $AuZn_3$.

Votes of thanks to the Principal of the College of Technology, to the members of the local reception committee, and to others who had contributed to the success of the meeting, closed the business proceedings. In the afternoon, by the invitation of the Manchester Ship Canal Company, a visit of inspection to the section of the canal between Manchester and Barton was made. A pleasant meeting came to a close by a visit to Chester on September 13th.

HENRY CORT.

In connection with the formal opening of the new metallurgical laboratories at the University of

Manchester, an account of which was given in last week's issue, the tablet of which a reproduction appears above, has been placed on the wall of the new laboratory in memory of Henry Cort, after whom the laboratory is named.

Mr. J. Phillips Bedson, in making the announcement of the presentation of the Cort medal, gave a brief summary of the life of the inventor. He was born in 1740 at Lancaster, and went to London in 1765, where he was a navy agent for the purchase of iron. He commenced the manufacture of iron at Fontley near Fareham, several years later, and was the first, it is said, to puddle iron with coal, which he did in 1784. Following the taking of a partner by name Jellicoe, a deputy paymaster in the navy, the business came to grief, and Cort was ruined, losing at one swoop his work, patents, agreements and royalties. Rival ironmasters took advantage of his downfall, and utilised his patents to their own advantage, and although, as is well known, he made appeals for redress, he obtained none. He eked out the remainder of his days on a small pension and died in 1800. He was buried in Hampstead Churchyard.

The value of his inventions—he was the first to use grooves in rolls—was freely acknowledged by the generation which succeeded him, and he has been called the "father of the British iron trade." It was however left to an American ironmaster, Mr. Charles H. Morgan, who was President of the American Institution of Mining Engineers in the year 1900, to make a search for the last resting place of Henry Cort and to place a tablet, of which that on the walls of the new laboratory is a replica, in Hampstead Church.

It is an interesting coincidence that Professor Henry Cort Harold Carpenter, who was Professor of Metallurgy at Manchester University, and was present at the ceremony of the new laboratories last week—when the announcement of the institution of the Cort medal was announced—is a great grandson of the inventor.

IRON AND STEEL INSTITUTE AT MILAN.

THE annual meeting of the Iron and Steel Institute of London was opened in Milan at the Chamber of Commerce on Monday. Signor Falck, President of the Italian Association of Metal Industries, welcomed the guests in the name of Italy, and expressed the hope that the meeting at Milan and the visits to the factories in various Italian cities, would give new strength to the old friendship which had existed between the two countries. Mr. Samuelson, returning thanks, said that he and his colleagues wished to study Italy from the economic and social points of view, and affirmed that Italy had always been a source of progress to civilisation. After discussing reports presented to the meeting the members visited factories in the neighbourhood. The Chamber of Commerce subsequently gave a reception in their honour. On Wednesday the members went to Como, after which they set forth on a tour of Italy.

SIXTY YEARS AGO.

IN our issue of September 18th, 1863, much disapproval was expressed of the proposal to adopt the metric or decimal system in this country. Sir William Armstrong, in his presidential address to the British Association a fortnight or so previously, had come forward as an ardent supporter of the proposed change and many others were working for the same end. The arguments which we advanced in a leading article against the alteration were those which ever since have remained familiar to us with perhaps one exception. Commenting upon the decimalists' claim that their system was a natural one in that it was related to the number of fingers and toes possessed by human beings, we argued that the duodecimal system could by some be claimed to be equally natural. Zerah Colburn, the "calculating boy"—then editor of this journal and in all probability the writer of the article—had twelve fingers and twelve toes, a peculiarity which it was stated he shared with his brothers and sisters, his parents and grandparents. [Brothers and sisters we can understand, but why parents and grandparents—in the plural?] . . . In a note the Government was criticised for the tardiness displayed in the adoption of twin screws for naval vessels. It was then about to experiment with a twin-screw steam tug of 35 tons—in course of construction we gather from a reference in a previous issue by Messrs. Dudgeon, of Millwall—whereas in America the Federal Government had decided to construct four twin-screw vessels of 330ft. in length. The Admiralty was also criticised with respect to its adherence to the 95-cwt. 8in. gun, although the Americans were provided with 20-ton 15in. guns, throwing a shot of 420 lb. to 450 lb. weight. In the matter of manœuvring the American ships were also apparently superior to ours, for whereas they could turn their longest vessels almost upon their own axes, a space nearly as large as Spithead was required for the Warriors and Black Princes of the British Navy.

A NEW STEEL.

WE have received from the Park Gate Iron and Steel Company, Limited, of 38, Victoria-street, Westminster, some particulars of a new steel specially produced for use in automatic machines and capstan lathes, where high speed of production is desired. This material, it is claimed, is superior to any of the usual British "free-cutting" steels, and can be machined at from 25 to 33 per cent. higher speed, while it will withstand a deeper cut. A good smooth finish is obtained and the higher the cutting speed, the better is the finish, so it is said. In order to obtain these qualities, small quantities—from 0.09 to 0.12 per cent.—of sulphur and phosphorus are deliberately added to the metal, but by careful manufacture these elements are prevented from segregating. The steel also contains about 0.1 per cent. of carbon, 0.03 of silicon, and 0.6 of manganese. It is supplied in the form of billets, round or hexagonal bars, and is drawn down to the required size. The results of tests given show that the bright drawn bar has a yield point of from 32 to 39 tons per square inch and a tensile strength between 35 and 45 tons, while the elongation on 2in. is 15 per cent. and the reduction of area at the fracture ranges from 40 to 45 per cent. The bar can be bent through 180 deg. without breaking. The black bar naturally has a slightly lower tensile strength and a greater elongation.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE EMIGRATION OF WORKMEN.

SIR,—It would appear from the statements in THE ENGINEER, editorially and otherwise, that the employers have at last realised that their warfare against the working man has been too successful, and that with Government, Press, and employer against them, those of the working class who could raise the money have abandoned England altogether. The Engineering Federation you quote as being alarmed at the number of non-indentured boys, may find it a Titan's task. You and they do not seem to realise that even now the working man looks upon trades as a blind-alley occupation, and to think that he will undertake the responsibilities of an apprenticeship for his child with those he has stern reason to recognise as his most vindictive enemies, with the bountiful reward for the lad of 57s. per week, is to qualify him for an asylum. The mischief has been done, or else you might have admitted before this to those you represent—the employers—that, although you may take a leaf out of America's book and equip the finest engineering works in existence and the best—doubtful—brains your universities can produce, it would simply be a white elephant without skilled hands to operate. At the present time, workmen prefer the horrors of Ellis Island to life under the English rule. The writer, whose only son leaves school at Christmas, will meet the Juvenile Committee of the local labour exchange at that time, and to any proposition of trades will give the answer the Cardinal of Rheims is supposed by history to have given the Jackdaw.

The writer, who has left it too late this year, has the definite intention of straining every nerve to leave the country he was mad enough to serve in the last financiers' dispute for that where there is a prospect of a square deal.

September 17th. EX-SERVICE.

MARINE ENGINEERS' CERTIFICATES.

SIR,—In your article of 31st ult. you state that the candidate for Board of Trade certificate finds his course of study set forth in a clear and orderly syllabus. This was true until the year 1919. Until then the theoretical knowledge required was indicated by the 310 elementary questions published in the official regulations, and the examinations might be said to be specialised in marine engines and auxiliary machinery. These questions have now been dropped, and papers on "engineering knowledge" substituted. The new questions are not published, but the subjects relate indiscriminately to civil and mechanical engineering, shipbuilding, physics, &c.

The new examinations are well suited to young college men, but such are not likely to take up a seafaring life for more than a few years, as they naturally feel that with their qualifications they will have more scope on shore. To the specialised practical marine engineer, the present examinations seem cruelly stringent. Should he pass after painful study, his learning soon vanishes, for he has no practical use for it. The irony of the case is that men with steam certificates, who for years have been successful chiefs of motor vessels will have to leave for re-examination or return to steamers.

September 12th. EXTRA FIRST.

ELECTRICITY GENERATED BY SAFETY VALVES.

SIR,—Replying to your inquiry in reply to my letter on the above subject in last week's issue of your paper, the safety valves are jointed on to the boiler stands with Dixon's compound and lead wire.

I might add that since my last letter I find that by standing on a rubber mat a spark of about ¼in. in length can be obtained from the hand rail of a platform which runs along the top of the six boilers, but which does not rest on any of them, and is not in metallic contact with the boilers, excepting through iron ladders which rest on wrought iron columns which support the roof and which carry hangers for supporting the main and steam feed pipes. Although I can obtain an electric arc from the hand rail, I was surprised to find that I could not get a spark from any part of the boilers.

I have been rather interested in the matter, as the experience is quite new to me.

Grimsby, September 12th. F. A. FLEMING.

MULTI-CYLINDER LOCOMOTIVES.

SIR,—I read with much interest your article on the relative merits of three and four-cylinder locomotives. The Great Western Railway, at any rate, has produced very successful four-cylinder engines, if we may judge from the fact that that type is almost exclusively used for hauling the "Cornish Riviera Express" between Paddington and Plymouth, the longest non-stop run in the world, I believe. How well these engines perform that great run of 225¾ miles is evidenced by the fact that, notwithstanding the severe gradients—exceeded only on a main line by the Lickey incline at Bromsgrove—between Newton Abbot and Plymouth, this famous train with eight of the heaviest coaches, totalling about 260 tons, besides the 115 tons or so of engine and tender, is rarely late. Its daily arrival at the almost exact minute is indeed always an interesting sight to an admirer of fine locomotives.

September 11th. F. P.

SIXTY-FOOT MOTOR LIFEBOAT FOR NEW BRIGHTON

Motor Lifeboat for New Brighton.

THE New Brighton 60ft. motor lifeboat, which we illustrate above, is stated to be the most powerful lifeboat in the world. She is 60ft. long with a 15ft. beam, a draught of 4ft. 6in., and a displacement of about 40 tons. Her twin screws are driven by two 90 horse-power motors, which have been specially designed by the Royal National Lifeboat Institution for its motor lifeboat service, and which were illustrated and described in our issue of December 22nd, 1922. In addition, she has an auxiliary rig of one mast, carrying a small triangular fore-lug and jib. She has a speed of about 9 to 10 knots, and a radius of action of 150 miles. The largest motor lifeboat previously built by the Institution measures 46ft. 6in. by 12ft. 9in., is fitted with one 90 horse-power engine, and has a speed of 8.5 knots. These figures show the great advance which is being made with the new boat. The 60ft. vessel is practically unsinkable. She is built almost entirely of a double thickness of teak, with light mild steel bulkheads, and has nearly one hundred buoyant air cases, each of which is virtually a water-tight compartment, so that she has practically as many water-tight compartments as a modern battle-cruiser. Each motor also is in a separate water-tight compartment, as a precaution against fire and against flooding. It will, in fact, be possible for the wing compartments amidships to be flooded without any water getting into the engine compartments. In addition to her increased size, speed and range, this new lifeboat has several other novel features. She has two cabins, one fore and one aft, to hold fifty passengers, while the total number able to be taken on board is over 150. One of the cabins is fitted with a stove, and thus, for the first time, it will be possible to give the rescued, who are often in a state of exhaustion and collapse from long exposure, shelter, warmth and warm food. Like other motor lifeboats, she carries a line-throwing gun, and, in addition, has a searchlight and a life-saving net. The net is stretched across amidships, so that when she is alongside a vessel high out of the water, the people on board will be able to jump into it. Wherever possible, mechanical power is used. There is an auxiliary motor to work the bilge pump, the winch, the capstan and also the dynamo for the searchlight and general lighting purposes. The New Brighton boat has cost about £18,000 to build, part of which sum is the gift of two generous Liverpool donors.

ELECTRIFICATION OF WEST FLANDERS.

ACCORDING to a report, published in the *Neptune* of recent date, forwarded to the Department of Overseas Trade by the Commercial Secretary at Brussels, the Provincial Government of West Flanders, following the lead of the other provinces, is now considering the electrification of its townships, several of which are still without electric light. Out of the 242 townships in the province, 94 are provided with gas and 59 have electricity.

On making a comparison it would appear that about half the population have the use of electricity, while the larger portion of the other townships have either directly or indirectly granted concessions for the supply of gas. The result of this, which makes the problem a difficult one, is that a deficit may be expected in the case of townships requiring the intervention of the province. This deficit may be estimated at about one million francs per annum.

Two methods of working the scheme are to be considered:

(1) For the devastated regions, the province would provide high-tension lines from the power station to the township. The province would buy the current from the power station, carry it to the township and sell it to the local company holding the concession.

The first line on which this method might be tried would run from Ostend to Furnes, Dixmude, and Gits, over a length of 198 kiloms., supplying 46 townships. The cost is estimated at six million francs. A second line, 57 kiloms. in length, would go by Ramscapelle, Leke, and Pollinchove, supplying 22 townships, and would cost 1,725,000f.

Altogether the installation of the system in the devastated regions would cost 7,725,000f. and ensure the supply of electricity to 68 townships with a total population of 114,409.

(2) The intervention of the entire province, in the installation costs of low-tension current, would amount to one-third, or 7,115,000f., 5,000,000f. for the undevastated part and 2,115,000f. for the devastated regions.

Altogether the total electrification of the province will cost about fifteen million francs.

Australian Engineering Notes.

THE Royal Automobile Club of Victoria will again hold a 1000 miles alpine reliability test this year, probably in November. Several drastic changes have been made in the conditions which applied last year. With regard to standard cars, in addition to valve cams, gear ratios, pistons and compression, no alterations will be allowed in the standard carburetter, ignition, petrol feed, and cooling systems, or attachment to secure petrol economy, except an extra air valve. In view of the extraordinary mileages claimed in previous petrol consumption tests, under the system hitherto employed, in future all cars will be allotted a certain allowance of petrol for the first day's run, and every car completing the first day without exceeding the quantity allowed will obtain the maximum points for fuel consumption.

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IT is now estimated that the scheme for the conserving of the waters of the Murray River by the construction of a series of locks will cost £10,000,000. The House of Representatives has passed the Bill authorising the Commonwealth to pay one quarter of that sum, while Victoria, New South Wales and South Australia will pay the remaining three quarters.

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THE South Australian Government has approved of the remodelling of its Islington locomotive workshops. The work will be proceeded with shortly. The remodelling of the works and the provision of new machinery will cost, approximately, £250,000. The Government has also called for tenders for ten rail motor cars, five to have a seating capacity of fifty, and the other five of twenty-five. The cars will be placed on country lines where the traffic does not warrant steam trains.

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THE building of the new capital of Canberra definitely began on August 28th. Mr. Stewart, Minister of Works and Railways, who turned the first sod for the provisional Parliament House, made a speech in which he said that he proposed to speed up the work so that the next Parliament might be opened in the new city, which was to be a garden city rather than a monumental one.

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THE Sydney Water and Sewerage Board has awarded a contract to Patterson Brothers and Teesdale Smith for the construction of a new reservoir at Centennial Park, to hold 19 million gallons. The work, which will probably take a year, will cost £172,000.

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As a result of the quarterly adjustment of wages in the engineering trade in Australia, based upon the estimated increase in the cost of living, a general increase of 4s. per week in the trade was gazetted on July 1st. Fitters now receive £5 10s. 6d. per week.

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THE list of works proposed by the Launceston City Council during the current year are reported to include the following items:—Waterworks extensions, £3201; tar-macadam mixing machine, £350; street construction, £4967; tramway extension, £10,428; general sewerage works, £20,000; tramway tower wagon, £650; electricity works, adaptation of distribution system for higher voltage, £9500.

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THE attention of the Customs Authorities was recently directed to complaints of insufficient tariff protection. It was asserted that oversees firms had been able to quote 20 to 50 per cent. less than Australian tenderers, and in consequence manufacturers outside the country had secured more than 40 per cent. of the total engineering contracts in the Commonwealth. The Deputy-Controller-General of Customs stated that in no instance within his knowledge had the difference in cost between the Australian and oversees manufacturer extended to 50 per cent. of the value of the machinery. The action of the Customs Department hinged upon whether the machinery could be manufactured in Australia. If it could be commercially manufactured in the country, no consideration was given to any application for free admission. In cases in which the machinery was absolutely necessary for the foundation of a new industry, however, or for the expansion of an existing industry, the Department gave favourable consideration to applications for remission, always bearing in mind the capacity of the local engineering firms to meet the demand.

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IT is reported that Mr. Charles Hoskins, director of Hoskins Limited, steel makers, Lithgow, N.S.W., informed the Public Works Committee of the New South Wales Parliament, which is conducting an inquiry regarding a proposed railway from Moss Vale to Port Kembla, that if the line were constructed his company would expend £2,000,000 on the erection of iron and steel works at Port Kembla where 380 acres of land had been secured. This would not mean the closing down of the Lithgow works. Mr. Hoskins explained that the Lithgow works were practically unable to compete for inter-State trade, by reason of the freight charges from Lithgow to Sydney. If the proposed line were built his company would draw iron ore and limestone from the southern district, and would effect a saving of 5s. per ton on ores, in comparison with the freight *vid* Sydney, which was equal to 12s. 6d. per ton on the finished article. He considered that if iron and steel works were established at Port Kembla, they, in conjunction with the Lithgow and Newcastle steel works, would still be unable to supply the iron and steel required in Australia, if the country were to progress as anticipated.

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EFFORTS are being made to revive the shale oil industry in New South Wales, and British capitalists are said to be willing to advance considerable sums in order that a thorough test of the shale field may be made. Their decision was made on reports which showed that in certain areas a yield of 2500 tons of shale per acre, averaging 100 gallons of crude oil per ton, can be expected. With a retorting capacity of 300 tons per day, any company holding good average shale deposits could, it is stated, supply 30,000 gallons of crude oil per day for over 100 years. It is argued that up to the present no shale oil project in Australia has been equipped with an up-to-date retort, and as an essential prelude to the revival of the industry, it is considered necessary that a committee of experts should conduct actual bulk trials of high-grade shales on the field, with a view of devising a retort suitable for their treatment. It is also argued that instead of transporting oil in tank trucks by rail vast economies could be effected by the building of a pipe line from the retorts to the refineries on the seaboard. The erection of such a line from a central point on the Dividing Range to Newcastle is said to present no difficulties that cannot easily be overcome.

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THE South Australian Government has decided to proceed with the conversion of all State railway lines of 3ft. 6in. gauge to the 5ft. 3in. gauge, which is already in use in portions of the State and is also the standard gauge in Victoria. The work of converting the existing narrower sections will take about five years, and will mean an expenditure of approximately, £1,000,000. The authorities have decided to make a beginning immediately. The South Australian Government also intends to construct fifty new coaches, including new dining and café cars. The cars will be similar to those in use on the English railways, and tenders for their construction are being invited both in Australia and the United Kingdom.

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THE Victorian Minister for Railways recently announced in Parliament that seven hundred railway carriages were being converted from gas to electric lighting.

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IN Sydney the construction of a high-pressure tunnel to modernise the water supply of the city, and assure the adequate distribution of water for years to come, is at last under way. The scheme provides for two pipe lines, each 6ft. in diameter, which will enable 100 million gallons daily to be brought to the city. The work will cost about £1,500,000.

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PLANS are being prepared by the Geelong Water Works and Sewerage Trust for a reservoir on the Moorabool River to contain 1000 million gallons of water.

THE natural gas industry in Rumania seems likely to make great strides in the future. The most important centres in this connection at present are Kissarmas and Mediasch. In the vicinity of these towns a new and abundant supply has been discovered. Between Mediasch and Bazna there is at present a pipe line of 150 mm. diameter, but this line will shortly be replaced by one of 500 mm. diameter, in view of the increasing demand for the gas in Mediasch for new industrial enterprises. Mediasch is the largest industrial centre in Transylvania. Among its establishments are glass factories, leather and harness works, an enamelled hardware factory, &c. At Bazna fresh strata are being bored and wells deepened. On completion of negotiations for creating a national natural gas company, plans for conducting the gas to Cluj, the capital of Transylvania, will be elaborated. The Government proposes, in addition, to send geological experts to study how the large towns adjacent to the gas wells could be supplied with gas for lighting and power purposes.

Improved Type of Thrust Boring Machine.

ON several previous occasions, notably in our issues of April 9th, 1920, April 23nd, 1921, and March 10th, 1922, we have referred to the Mangnall-Irving thrust boring machine, which is made by the Hydraulic Engineering Company, Limited, of Chester. Recently the apparatus has been further developed, and we understand that a machine known as type G has now been standardised for making 3in.—pilot—4in., 5in. and 6in. holes. The main difference between this machine and those which preceded it is that, with it, after the pilot hole has been driven or "pushed" through, all further work of enlarging can, be and is, usually done by "pulling." The three main advantages claimed for the latter method of procedure as compared with enlargement by "pushing" are:—

(1) That since the boring tube is put in tension, much greater force can be exerted than when it is used under compression;

(2) That for the same reason, bent tubes under heavy loads are avoided; and

(3) That the cable or pipe to be laid may be made to follow immediately behind the enlarging head.

The re-designed apparatus is shown in the accompanying engravings. The machine comprises two side tubes, which are internally threaded at each end for the reception of jacking screws provided with tommie-bars for adjustment purposes. The outer ends of the screws are provided with thrust plates attached in the manner shown in the drawing. When in position, the tubes are accurately parallel with one another. In the centre of the length of each tube is fixed a brass piston, which is furnished with hydraulic cup leathers. Upon this piston fits a cylinder which is caused to move endways, in either direction, by hydraulic pressure. Each side tube has its own cylinder, and the two cylinders, which are interconnected by piping, are rigidly tied together at each end, so as to form what is, in effect, one solid crosshead. The pressure water is supplied through a control valve, which is so constructed that when the handles are down, as shown in the drawing, the pressure is applied at the left-hand ends of the cylinders and the "crosshead" moves to the left. On the other hand, when the valve handles are turned through a right angle so as to stand vertically, the pressure water is admitted to the right-hand ends of the cylinders, and the "crosshead" moves to the right. When either handle is in the half-way position between the horizontal and the vertical, there is free communication between the two ends of the cylinders, so that they can be moved readily backwards and forwards along the tubes or rods. This attribute is made use of in order to obtain a quick return of the "crosshead" for the purpose, either of adding new rods when initial thrust boring is taking place, or for removing the rods when enlargement of the bore-hole is being carried out. To effect the quick return, a rod furnished with a toothed rack is arranged parallel with and not far from one of the side tubes, and a hand wheel, on the spindle of which is keyed a toothed pinion, is attached to the "crosshead." With the control valve arranged as explained, the "crosshead" may be made to travel rapidly along the tubes in either direction by simply turning the hand wheel. At the right end of the "crosshead," as shown in the drawing, there is fixed between the two cylinders a thrust block, through a hole in which can be passed a screwed pin, which is used for centring the pilot bar or boring tubes, and also for taking the load when the machine is used as a puller.

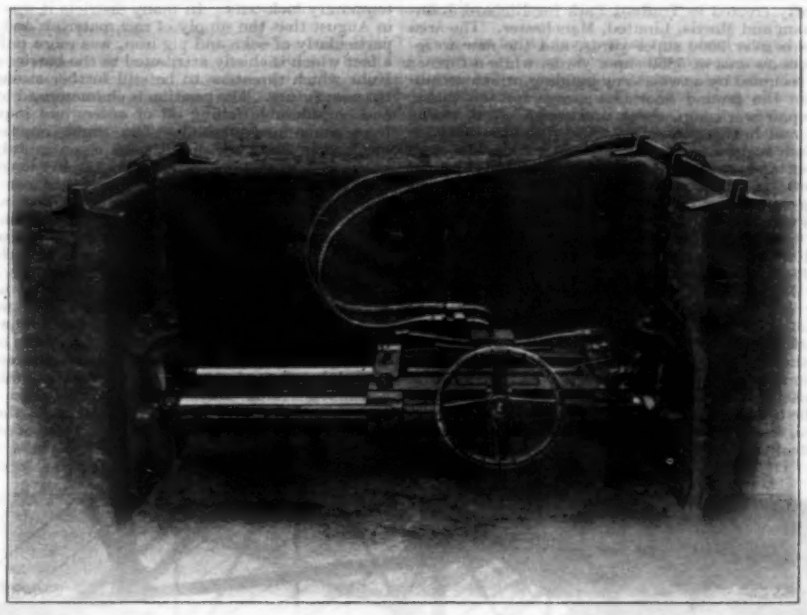
Saving for the foregoing, the type G machine does not greatly differ in construction or operation from those which we have described in the previous issues above alluded to. It should, however, be mentioned that it is not necessary, as it was in the earlier machines, to swing a cylinder to the vertical before a rod can be inserted or withdrawn. The machine may hence be used directly below a gas or water main or with a bunch of cables crossing the boring pit.

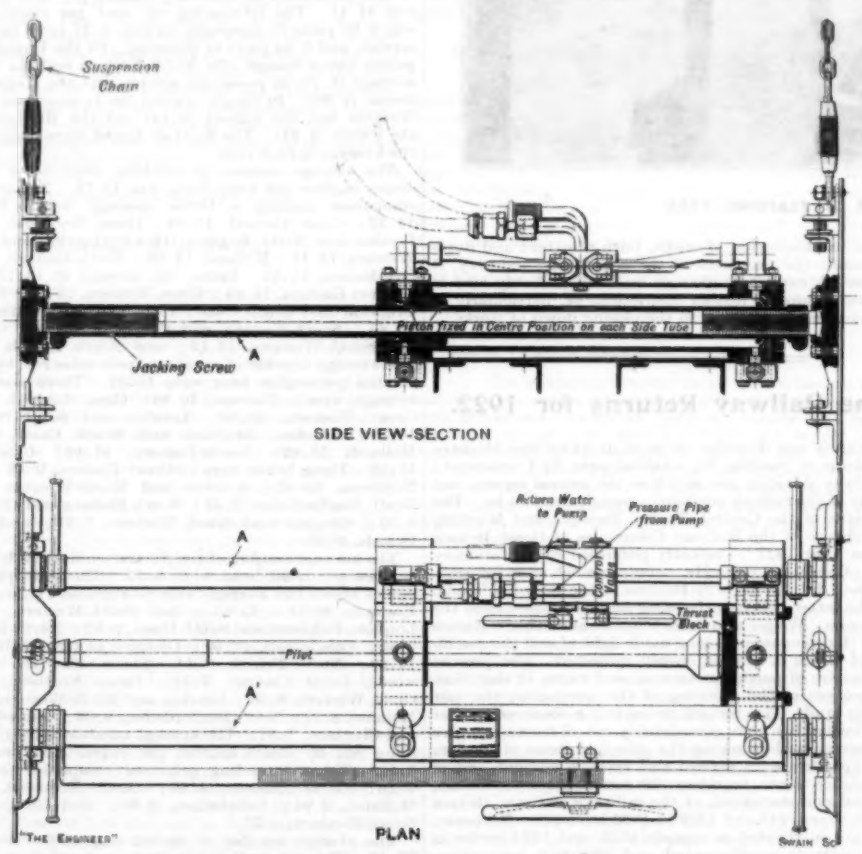
Further advantages claimed for the new mechanism are:—(a) That the machine being self-contained and capable of operation under load in either direction at will by the movement of the valve handles, it is not necessary to employ special gear for withdrawal, as it was with the earlier units, so that much time is saved. We are informed that the boring speed—when using a hand-operated pump—is from 50ft. to 90ft. per hour, including coupling the rods, the diameter of the hole formed being 3in. (b) Withdrawal of the rod may take place instantaneously at any point of the stroke. Resulting from this possibility, there is the additional advantage of being able to pull back the pilot a few inches and then to send it forward again. This repetition of blows is useful in the case of meeting an obstacle, the resistance of which is, it is stated, usually to be overcome in this manner.

The normal dimensions of the boring pit to contain the machine is 4ft. 4in. long—that is to say, in the direction of the boring—and 2ft. 6in. wide; 60ft. of boring tube—in lengths of 3ft. each—are supplied with each machine as standard practice, though operations are not, it should be understood, limited to that range. The stroke of the machine is 18in.—just half the length of a boring tube—so that two machine strokes per tube length are required. The total weight of each unit complete, including the boring tubes, is 11¼ cwt.

MANGNALL-IRVING THRUST BORING MACHINE

THE HYDRAULIC ENGINEERING CO., LTD., CHESTER, ENGINEERS





SECTIONAL ELEVATION AND PLAN OF THRUST BORER

THE PORT OF SAN ANTONIO, CHILE.

THAT San Antonio, the new Chilean port about 20 miles to the south of Valparaiso, is becoming a serious rival to the latter, is exemplified by the latest official figures bearing on the shipping traffic at the two ports. The port of San Antonio was begun under the administration of the President, Don Ramon Barros Luco, and its principal feature is its breakwater, 1700 m. in length, that has successfully withstood all the big storms and which encloses an area of 750,000 square metres of water where shipping operations can be carried on in calm water in any weather. The "northers," which are so disastrous in the port of Valparaiso, cause no damage in San Antonio, as the entrance to the bay looks west, while on the north side the bay is protected by a high hill separating San Antonio from the bathing resort of Cartajena.

The breakwater, or large mole, has twenty-seven electric cranes, one of which has a capacity of 40 tons. Steamers up to the size of 10,000 tons discharge direct from the mole, either on to the railway tracks of the line connecting the port with Santiago (the capital) or into the fiscal warehouse, a fine concrete building of four storeys. Loading and discharging are also done by means of lighters, steam tugs, &c., which are owned by different firms that have interested themselves in the port. Passengers for Santiago, from mailboats which arrive *viâ* Magallanes, avail themselves of the comfortable landing-stage situated in the inner port, and, taking an afternoon train, reach the capital early in the evening.

The cargo capacity of the port is 600,000 tons, and at present 400,000 tons are being handled yearly. Great interest is being shown in the capital as a result of the Government having declared San Antonio a "puerto mayor." A major port, or "puerto mayor," is a port at which goods from foreign countries can be imported direct, and it is foreseen that San Antonio, with the construction and development of new railways, notably that from the port of Las Cabras, shortly to be begun by private enterprise and without Government assistance, will become a chief distributing centre for the central provinces of Chile.

Many commercial firms, including some British, have built warehouses on land reclaimed from the sea, and the Government has sold by auction further lots for the same purpose, all with railway sidings connecting up with the mole and the main line to Santiago.

THE Austrian Government announces that both radio telephony and radio telegraphy are to be retained as State monopolies. The right to develop services between Austria and other countries has been leased to the Marconi Company. Negotiations, however, are pending with regard to an inland service, particularly as to broadcasting and ordinary radio telephony, which have, so far, remained entirely neglected in Austria. The concession in this case will only be granted to an Austrian firm or an amalgamation of such firms under the condition that exclusively Austrian machinery and appliances are installed. A number of applications for concessions have been received. The concessionnaires will be entitled to fix their own tolls and "rentals," in which the Government will participate on a percentage basis.

Ferro-Concrete Warehouse at Manchester.

IN order to expedite the distribution of their goods, the reinforced concrete warehouse illustrated herewith has been recently erected in Trafford Park for Richard Johnson, Clapham and Morris, Limited, Manchester. The area of the site is over 9000 super yards, and the new warehouse covers an area of 5860 super yards, while a further portion is occupied by a two-storey building, which accommodates on the ground floor the garage for ten motor wagons, repair workshop, check and weigh office, works lavatories and heating chamber. The first floor contains kitchen and larders, a canteen for the workpeople, staff dining-room and caretaker's flat. The warehouse proper is constructed of reinforced concrete stanchions and beams supporting cantilevered galleries down the sides of each bay, the area of the galleries being 40 per cent. of that of the floor. The ground floor is constructed of 9in. concrete, reinforced with two layers of Johnson's reinforced concrete meshing and covered on top with 1in. Limmer rock asphalt. The site was covered with a layer of peat, averaging 4ft. in thickness. The stanchion foundations have therefore been carried below that depth and reinforced with a steel grille. The side walls are filled in between the concrete stanchions with 4½in. brickwork, built in cement mortar and reinforced every third course with Johnson's "Bricktor." The whole of the moulded work to the front elevation, including the heavy overhanging cornice, &c., has been cast *in situ*. The roof is formed of light steel trusses, fixed at 12ft. centres, bolted to the top of the concrete stanchions and covered with 9in. by 3in. wood purlins 1in. T. and G. boards, roofing felt and asbestos slates on one side, the north side having two-thirds of the area filled in with patented roof glazing. The whole warehouse is heated on the low-pressure hot-water system from three "Ideal" boilers fixed in a special chamber.

REINFORCED CONCRETE WAREHOUSE IN TRAFFORD PARK

The lay-out of the warehouse is such that goods can be handled—received by road and despatched by road or rail—with great rapidity. Elevators are fixed to convey goods, such as nails, bolts and nuts in quantity, from the ground floor to the galleries, and there are chutes for despatching goods from the galleries to the ground floor. The elevators are operated by 2 horse-power electric motors and belting, and have tip-up buckets, which automatically deposit their contents on the gallery floors. They were supplied by the Ewart Chain Belt Company, Limited, of Derby. A private railway siding runs across the full width of the warehouse at one end.

The contract, amounting to £28,343, was given to James Byrom and Co., Limited, Bury, Lancashire, the principal sub-contractors being Johnson's Reinforced Concrete Engineering Company, Limited, for the reinforcement; John Booth and Sons, Bolton, for the steel work; W. T. Glover and Co., Limited, for the roof glazing; Saunders and Taylor, Limited, for the heating apparatus; Henry Hargreaves and Son, Bury, for the ventilation; and Wm. Hodgson and Sons, Manchester, for the 20-ton weighbridge. The architect for the whole of the work is Mr. Arthur Clayton, M.S.A., Manchester.

It is interesting to note that the cost of the building works out at under 4d. per cubic foot, which is approximating to pre-war price.

THE ENGINEERING POSITION IN GERMANY.

UNDER the influence of the renewed and terrific depreciation of the mark, the position of the German engineering industry has become considerably more unfavourable. In numerous factories, it is stated, the number of workers is far in excess of requirements, but, owing to legal provisions, the necessary retrenchment can only be accomplished by the introduction of short time. Wages and salaries have been adapted to the depreciation of the mark and increased costs of living by repeated tariff increases, and, in consequence, in several districts, more particularly in the Occupied Territories, they now exceed pre-war rates. The discontent among the workers brought about by wage disputes has been aggravated by the extraordinary shortage of currency for wages, which has induced a section of the workers to adopt a policy of passive resistance, a measure which has been replied to at certain works by temporary lock-outs. In many districts it was noticeable in August that the supply of raw materials and fuel, more particularly of coke and pig iron, was more unfavourable, a fact which is chiefly attributed to the barrier around the Ruhr which threatens to be still further strengthened in the near future. The position is characterised by a general and considerable falling off of orders and inquiries both from home and abroad. The slight improvement of business in June, which fell away again in July, did not, in general, supply sufficient orders for any length of time. The very large increases in the prices of raw and semi-manufactured materials, some of which now cost several times the world market price, the high wages and salaries, the increase by many times of freights, as well as the increase in all other costs, make production charges considerably above pre-war rates. Competitive quotations abroad can only be achieved, therefore, by sacrifices in price and conditions of payment. On the home market, in addition to the general holding back in the placing of new orders, considerable difficulties are being experienced owing to consumers trying to cancel contracts already placed in view of the difficult economic position. The continued traffic barrier between Occupied and Non-occupied Germany, the rate of exchange, the drain on working capital by the tremendous increase of raw material prices, wages, freights, and duties, the new taxes and, finally, the limitation of credit, both in extent and duration, make the prospects of the engineering industry, it is reported, extremely gloomy, and will probably lead in the near future to further restrictions or, particularly in the Occupied Territories, to the closing down of works.

The Railway Returns for 1922.

THERE is one direction at least in which the Ministry of Transport justifies its establishment and existence; its railway statistics are as full as the annual reports and returns of the railway companies permit them to be. The "Returns of the Capital, Traffic, Receipts and Working Expenditure of the Railway Companies of Great Britain for the Year 1922"—recently published as a Stationery Office publication, price 21s.—contain much more information than did the Railway Returns of the Board of Trade. Yet the latter had just the same annual reports from the companies. We get also those ton-mile and other statistics which the companies so long made light of and the usefulness of which is now so clearly indicated. The present Returns are of particular interest and value, in that they are, because of the grouping of the companies, the last of their kind. This remark prompts the observation that the Ministry has gone considerably out of its way to give a summary table showing the principal items of receipts and expenditure on capital and revenue account and of the balance sheets, together with certain other particulars, financial and statistical, of the railways of Great Britain for the years 1913 and 1919 to 1922 inclusive. Moreover, they are subdivided as regards 1913 and 1922 so far as they relate to amalgamated and absorbed companies, into totals for the four groups.

It is altogether out of the question to review these Returns as a whole. We can only deal with those which appeal particularly to engineers, and we shall therefore omit all mention of capital and of traffic. But we must say, on the subject of capital invested in businesses other than the railway, that of the £8,191,276 invested in canals at the end of 1922, the Southern group had £77,700, the Great Western £797,517, the London, Midland and Scottish £6,163,258, and the London and North-Eastern £1,145,109. Of the £53,047,359 sunk in docks, harbours and wharves, the Southern had £6,618,670, Great Western £14,165,403 London, Midland and Scottish £8,464,235, and the London and North-Eastern £22,582,776. Of the £8,187,145 invested in hotels, the Southern group had £1,384,739, Great Western £108,869, London, Midland and Scottish £4,288,396, and the London and North-Eastern £2,382,578.

The traffic receipts for the whole of the British railways were £217,349,631 and the expenditure £174,844,342, leaving net receipts from the railways £44,486,351. In 1921, when the expenditure was £226,767,460, the net receipts showed a loss of £8,970,469, and in 1913, with an expenditure of £75,704,320, the net receipts were £46,113,893. Out of the £174,844,342 expended in 1922, maintenance and renewal of way and works cost—the figures for 1913 are added in brackets—£28,538,124 (£11,877,578); of locomotives, £14,987,374 (£60,623,88); of carriages, £8,091,794 (£3,647,635); of wagons, £9,131,936 (£3,619,553). Locomotive running expenses cost £40,064,498 (£17,239,375) and traffic expenses £56,117,645 (£23,568,029).

In the maintenance and renewal of the permanent way there were used, during 1922, 1,453,171 cubic yards of ballast, 184,088 tons of rails, and 3,165,406 sleepers. No new locomotives were charged to capital account, 312 were renewed, and 8385 were heavily repaired. Charged to capital account were 125 coaching vehicles, while 720 were renewed, and 23,813 were heavily repaired. There were 169 wagons charged to capital account, 8074 were completely renewed, 1889 were partially renewed, and 137,104 received heavy repairs.

As showing the amount of work that had to be done, we give the following figures for 1922 and, in brackets, those for 1913. They show what was in the shops at the end of the year under or awaiting repair. Locomotives, 4348 (3259); coaching vehicles, 7226 (5698); wagons, 29,007 (18,818).

There were 3645 privately owned wagons registered during the year. Of 3109 coal or coke wagons, 2733 were of 12 tons capacity, 101 of 15 tons and 101 of 20 tons. There were 260 tank wagons, practically all of 14 tons capacity, and 276 lime, salt, brick, &c., wagons, all of 12 tons.

The pounds of coal consumed per engine-mile were:—In passenger service 48.82 and in freight service 63.89. The principal companies below the first figure were:—Furness, 43.95; Great Western 40.34; London and South-Western, 39.00; London, Brighton and South Coast, 41.88; North-Eastern, 47.05; North Staffordshire, 46.27. Above the average of 48.82 were:—Great Central, 50.36; Great Eastern, 52.60; Great Northern, 53.61; London and North-Western, 51.63; South-Eastern and Chatham, 50.14; Caledonian, 61.00; Glasgow and South-Western, 64.58; and North British, 59.56. The average for freight service was 63.89, and the companies below that figure were:—Furness, 55.42; Great Eastern, 55.24; Great Western, 55.06; London and South-Western, 44.94; London, Brighton and South Coast, 53.82; Midland, 58.35; North Staffordshire, 53.33; South-Eastern and Chatham, 56.60. Those above the average were:—Great Central, 71.25; Great Northern, 78.06; London and North-Western, 71.44; North-Eastern, 63.95; Caledonian, 77.72; Glasgow and South-Western, 69.38; and North British, 71.12. The amount of coal consumed by shunting engines per shunting mile was 41.41. The lubricating oil used per running mile was 6.96 pints in passenger service, 7.37 pints in freight service, and 5.84 pints in shunting. Of the English companies above named, the North-Eastern had the highest average (8.70) in passenger service, and the Midland the lowest (4.90). In freight service the London and South-Western had the highest (9.18) and the Midland again the lowest (4.91). The Scottish figures were much above the average in each case.

The average number of coaching train miles run by steam engines per train hour was 13.71. The principal companies making a better average were:—Furness, 14.22; Great Central, 15.69; Great Northern, 13.87; London and North-Western, 14.44; London and South-Western, 15.11; Midland, 13.88; North-Eastern, 14.11; Caledonian, 15.31. Below the average of 13.71 were:—Great Eastern, 11.64; Great Western, 13.63; London, Brighton and South Coast, 13.04; North Staffordshire, 12.25; South-Eastern and Chatham, 11.58; Glasgow and South-Western, 13.13; and North British, 12.33. The average number of coaching train miles run by steam engines per engine hour were 10.28. Those above this average were:—Furness, 10.88; Great Central, 11.69; Great Western, 10.61; London and South-Western, 10.81; London, Brighton and South Coast, 10.46; Midland, 10.82; North-Eastern, 11.16; Caledonian, 10.39. Those below were:—Great Eastern, 9.48; Great Northern, 10.07; London and North-Western, 9.93; North Staffordshire, 9.47; South-Eastern and Chatham, 8.50; Glasgow and South-Western, 9.31; and North British, 9.80.

The average number of freight train miles run by steam engines per train hour were 8.85. The principal companies above this average were:—Furness, 11.20; Great Eastern, 10.61; London and South-Western, 12.45; London, Brighton and South Coast, 9.82; North-Eastern, 9.59; Caledonian, 10.80; Glasgow and South-Western, 12.69; North British, 9.34. Those below the average were:—Great Central, 7.42; Great Northern, 7.98; Great Western, 8.60; London and North-Western, 8.37; Midland, 8.31; North Staffordshire, 8.06; South-Eastern and Chatham, 7.91. The average number of freight train miles run by steam engines per engine hour was only 3.51. The outstanding principal companies' averages were:—Great Eastern, 4.66; Great Northern, 3.90; Midland, 3.94; Caledonian, 3.95; and Glasgow and South-Western, 4.77.

The average number of loaded wagons per train was 23.12. The principal companies to exceed this average were:—Great Central, 24.41; Great Northern 26.94; London and North-Western, 25.58; Midland, 23.49; North-Eastern, 24.12. Those below the average were:—Furness, 20.25; Great Eastern, 21.62; Great Western, 23.05; London, Brighton and South Coast, 21.94; North Staffordshire, 21.26; South-Eastern and Chatham, 21.42; Caledonian, 19.73; Glasgow and South-Western, 19.35; North British, 19.38. The average number of empty wagons was 11.44 per train. The Great Central had 14.93; the North-Eastern, 13.38; Great Northern, 12.95; and the Midland, 12.42.

The percentage of the number of locomotives available in use each week-day was 89.36. The principal com-

panies exceeding this average were:—Great Northern, 98.13; Great Western, 95.40; London and North-Western, 92.53; Midland, 91.43; North Staffordshire, 91.23; North British, 92.67. Those below the average were:—Furness, 82.14; Great Central, 89.00; Great Eastern, 83.16; London and South-Western, 85.39; London, Brighton and South Coast, 73.11; North-Eastern, 83.58; South-Eastern and Chatham, 84.26; Caledonian, 82.71; Glasgow and South-Western, 88.77.

The net ton-miles per engine hour were 955.26. The principal companies which exceeded this figure were:—Furness, 1373.03; Great Eastern, 1065.68; Great Northern, 1085.83; Great Western, 965.54; London and South-Western, 1107.62; North-Eastern, 1414.86; Caledonian, 957.08. Those below the average were:—Great Central, 928.63; London and North-Western, 863.92; London, Brighton and South Coast, 835.23; Midland, 945.74; North Staffordshire, 930.28; South-Eastern and Chatham, 658.13; Glasgow and South-Western, 909.30; North British, 735.97.

LATIN-AMERICAN ENGINEERING NOTES.

THE Mexican Government, through the Secretaria de Agriculturo y Fomento, will shortly call for tenders for the carrying out of some important canalisation work at the mouths of the Laguna Madre, situated on the south-eastern border of the State of Tamaulipas, in close proximity to the Mexican oilfields. The contract for the work, if tenders are suitable, will be given to private enterprises, otherwise the Government will itself lease such dredgers as may be required and carry out the work.

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BIDS will shortly be invited for the steel work of a railway bridge to be constructed over the Mossoro River, State of Rio Grande do Norte, Brazil. The cost must not exceed 1000 contos (about £200,000).

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THE Chilean State Railways are calling for tenders for the installation of signals to be used on the Santiago–Valparaiso electric line, and for telephones for the southern system of railways. The installation will be in charge of a British engineer who has been engaged especially for this purpose by the head of the State Railway Department.

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A NEW Venezuelan port is about to be constructed near the city of Coró, where three important petroleum companies are also to construct docks to which pipe lines from the oilfields of Maracaibo will be laid. A large quantity of pipe line will be required, and it is hoped that the order will be placed in the United Kingdom, since a considerable amount of British capital has been invested in the petroleum companies in question.

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A CONTRACT has been entered into between the Government of Panama and Señor Don Enrique L. Huatardo for the construction of a new railway, about 30 miles in length, from Caledonia Bay, on the Atlantic coast, to a point between the Ucurganti and Sanson rivers, in the Valley of Chucunaque, near the borders of Columbia. The line will be of narrow gauge. The contract calls for the construction of one or more wharves at the Caledonia Bay terminal of the railway, capable of accommodating vessels of 1000 tons. A number of railway stations will also be built. It is stipulated that the equipment of the railway shall be up to date and complete.

MINING IN CANADA.

A REPORT on the mineral production in Canada for the first six months of 1923, recently issued by the Dominion Bureau of Statistics, shows that the mining industry has recovered almost entirely from the slump of the last few years. The total production of minerals amounted to 87,152,248 dollars in value, compared with 60,361,109 dollars for the same period last year, an increase of 44 per cent. The production of metallic minerals is valued at 39,244,614 dollars, and non-metallic minerals at 47,907,634 dollars. These figures show increases of 48 and 41 per cent. respectively. In the metallic section the outstanding increases were in the production of nickel and copper. The surplus stocks existing at the end of the war seem to have been absorbed, and from now on a steady production is looked for. The increase for the full year promises to be still greater, as one large potential producer did not start operations until well on into June. The gold mining industry is in a satisfactory condition, although the production shows a slight falling off from that of the corresponding period last year. With increased crushing capacities, and one new producer assured, it is expected that the 1923 total will equal that of 1922. The gold production of Canada for the first six months of 1923 amounted to 530,402 fine oz., valued at 10,964,382 dollars. Silver production also showed a slight falling off when compared with that in the same period of 1922. However, the outlook for this industry is particularly bright for the latter part of the year. Large shipments from the new silver mining districts of the Yukon will, undoubtedly, make up for any decline in production from the older camps. During the first six months, 8,336,946 oz., valued at 5,506,469 dollars, were produced, compared with 8,905,454 oz., valued at 5,997,199 dollars in 1922. The production of coal amounted to 8,722,205 tons, valued at 38,188,343 dollars, as compared with 6,205,388 tons, valued at 26,993,498 dollars, for the first six months of 1922. The increase amounts to 40 per cent. in quantity and 41.5 per cent. in value. Increased production is general throughout the list of non-metallic minerals, the most important being in asbestos. To the end of June 99,042 tons were sold by producers for 3,574,762 dollars, as compared with 54,846 tons and 1,894,232 dollars during the same period in 1922.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Increased Market Interest.

SIGNS of the autumn demand are still hazy, but the attendance on 'Change in Birmingham to-day—Thursday—was larger than has been the case of late, indicating increased interest in the activities of the iron and steel market. In spite of the continued depressing outlook, a large number of Midland makers and merchants persist in their belief that a definite trade revival is not far distant, many claiming that before another month is out business will have taken a decided turn for the better. To some extent this will be assisted by the demands from Japan in connection with reconstruction, some of which have already materialised. At the moment an increasing amount of buying is taking place from what may be called precautionary motives. It is considered unwise to get stocks too low in the present state of the market. The market is not sure of itself yet, but the symptoms are better, and if prices generally have made no recovery, the process of attrition has been arrested. There is a good deal of re-rolling of steel in the Black Country by mills which would otherwise be unemployed, but the price cutting which has been prevalent for some time is gradually disappearing, values being decidedly steadier all round.

Staffordshire Bar Iron.

The market for bar iron continues indifferent, though some of the Staffordshire finished ironmasters report rather more active conditions. The marked bar department is by far the brightest spot. These mills are quite well employed, but work is of a hand-to-mouth character. Producers would be only too glad to have some reserves of orders, but as it is, there is no disposition, with present costs, to interfere with the £14 10s. basis, which has now ruled for six months. For Crown bars the nominal quotation remains at £12, though £11 10s. is freely accepted. The nut and bolt trade continues depressed, and consequently there is only a very small demand for the bars used in the trade. Makers, whether Lancashire or Staffordshire, cannot get more than £10 15s. for their products. Staffordshire firms are prepared to shade even this figure rather than lose an order. Belgian bar iron continues to compete with local makes, being now quoted £8 17s. 6d. delivered Darlaston. An increasing quantity of this foreign material is coming into the district, indeed into the country as a whole. It is reported here that there is no less than twenty to thirty thousand tons of Belgian bar iron coming into the country month by month. The advantage of being able to give prompt delivery which lies with the home producer is of little avail against the great difference in the price of the native and foreign material. Wrought iron gas tube strip continues to be sold at £12 10s. to £12 12s. 6d., which is £2 5s. above the price at which steel strip for tube making can be bought.

Staffordshire Ironworks Changes Hands.

The well-known ironworks at Darlaston, South Staffordshire, of Tolley, Sons and Bostock, have been acquired by Guest, Keen and Nettlefolds, Limited, as a feeder for their nut and bolt works, of which they now have four, three in the Darlaston area having been lately acquired. The firm is one of the oldest and best-reputed of the Staffordshire manufactured ironworks producing merchant bar iron and strip iron. Only a month ago the firm was made a joint stock company, and now Guest, Keen and Nettlefolds have become sole owners. Satisfaction is expressed in Staffordshire iron and steel circles that the concern, which prior to being created a joint stock company was idle for three or four months, is now to be immediately reconstructed and re-started.

Rising Values of Sheet Iron.

The increasing demand for sheet iron has enabled makers to secure better prices for their product, and this week galvanised corrugated sheets of 24-gauge have been advanced 5s. per ton, alike for home and export consumption, making current quotations £18 15s. at works and £19 f.o.b. Liverpool. Works are well placed with orders and large business from Japan to meet the requirements in respect of reconstruction is confidently anticipated by Midland mills. The home demand is a relatively quiet side of the industry.

Pig Iron.

Pig iron inquiries have increased to some extent, and there are furnaces which have sold more iron than for months past, though this is not saying much. Prices are weak, although makers say they are not covering their costs of production by several shillings per ton. Derbyshire foundry iron can be bought for £4 12s. 6d. and Northamptonshire at £4 10s. Steady sales are being made with moderate lots, a hundred tons being about the maximum, but the market lacks confidence. Transactions in forge iron are of quite small dimensions at £4 4s. to £4 5s. for Derbyshire and £4 2s. 6d. for Northamptonshire. Sales might have been increased had furnaces been disposed to yield further to pressure. It is to be hoped, in the interests of both buyers and sellers, that bottom has been touched. Stability is the first need. With raw materials more firmly based a steadying of other branches of the market might be looked for. It does not appear that there are any great accumulations of pig iron in this area, and in most cases current production is strictly proportioned to the demand. The coke situation has eased a little, supplies being a little more plentiful on the 26s. basis for furnace coke. But the coke owners can easily dispose of their fuel for export at £1 17s. 6d. to £2, and there is consequently a strong inducement to cultivate the foreign market. A few firms are loyally carrying out their promise to see the needs of their blast-furnace customers supplied. The report as to the production during August is somewhat discouraging, 599,800 tons of pig iron having been made, as compared with 655,100 in the previous month. Part of this reduction is no doubt due to the holiday. It is unusual to damp down blast-furnaces for holidays, but several large firms adopted this course in view of the poor demand, although the furnaces are once more in operation.

Continental Steel Competition.

The fight for the steel billet and sheet bar trade has reopened. Under the stimulus of exchange movement continental shippers are endeavouring to recover a footing in this market. French billets have been offered round about £7 10s., and a small amount of business has been done. British mills that would in other circumstances take up the challenge are now too well employed to stir very much, and they are finding even more inquiry. Native billets can be bought at £7 15s., but an increasing number of steel works decline to compete at this figure and are quoting £8 and upwards. The selling of semi-finished material at £7 15s. is said to be confined to comparatively few firms laid out for mass production on economic lines. Some works still have the advantage of cheaper steel bought a few months ago, and in August, as the Board of Trade returns show, no less than 39,841 tons of billets were purchased abroad—an increase of several thousand tons on July—for finishing into all kinds of products, and doubtless much of this material has been re-shipped abroad, in the meantime finding work for many mills in Staffordshire and elsewhere. But it would have been more satisfactory if the whole of the steel had been produced in British mills. For finished steel Belgium continues to hold a commanding position in joists, delivering into this country at £9, against the home figure of £9 10s. The competition is unfortunate, as this happens to be a line in which the home demand is better than for several other classes of steel. In the steel market there is little new business about, though prices do not seem to have receded further. Tube strip, bedstead angles, and small bars are cut as low as they can go. The last mentioned run from £9 10s. to £9 15s. maximum, a midway figure being about the average. Angles continue to be quoted £9 10s. and tees £10 10s. There is no movement in plate values. It is interesting to note that the output in August of steel ingots and castings was only 582,700 tons, being much the poorest month of the year, representing a reduction from 624,300 tons on July. Unusually long holidays were taken by the steel works in August, and the figures are quite up to expectation.

Engineering.

General engineering in this district is little better off than the basic industries, and there appears to be no sign of a real revival. Inquiries are plentiful, but they rarely mature. Prices are being cut to such an extent that an order, when placed, often has little value from a profit-making point of view. Constructional business, although rather better recently, is only moderate, taken as a whole, there being no stability. A certain amount of business has been done with India and the Malay States. Firms making pumps report that, while a modest amount of shipping work is being executed, the absence of orders is being much felt. Firms generally are carrying on in the hope of better things.

The Canal Strike.

There is no development up to the time of writing concerning the canal boatmen's strike, though the men's union is stated to be considering whether the strike shall be extended to other canal workers. The stoppage has been complete now for nearly a month, and the men are apparently still determined to remain out till their complaint is recognised. Of the 500 or 600 men involved about 130 are Birmingham bargees, while at Wolverhampton and Braunston about 100 are out. Other Midland towns affected are Coventry, Stoke, and Nottingham.

Unemployment.

Unemployment in the Midlands, I am glad to be able to state, has again turned in the right direction, the latest returns showing a slight decrease in the number of persons out of work, the figures being 170,596, as compared with 171,245 for the previous week. The decrease is, however, insufficient to bring the number down to where it stood a fortnight ago, namely, 169,733. The workless number in the Birmingham area is 42,595, in Bilston 4227, in Coventry 6015, in Cradley Heath 5291, in Smethwick 5586, in Stourbridge and Brierley Hill 3629, in Walsall 6514, in West Bromwich 3861, and in Wolverhampton 8166.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

General Conditions.

ALTHOUGH there have been some slight rumours of a better state of things in various parts of the country, one cannot find any confirmation in the condition of Manchester trade. The dulness of business here seems quite unrelieved, and people are rather sceptical about the future. Nevertheless, we are probably not far off bottom prices in most sections of the iron and metal markets. The difficulty, of course, is to decide how long we have to remain at the bottom before there can be any upward movement. Those who have any long experience of the iron trade will remember that sometimes these quiescent periods last over two or three years. Such a period of stagnation may, for all we know, be confronting the markets at the present time.

Metals.

The small improvement in the tone of the copper market seems to have passed for the present, and things are looking very dull again. What is really surprising is that, with trade as bad as it undoubtedly is, so much copper is going into consumption; but it is fairly evident

that the output just now is too heavy for the markets. There will be a slight reduction in the world's output as a result of the Japanese earthquake; but it will not be great, as the larger part of the Japanese production is said not to be affected by the disturbance. What is needed to get the market into a safer position is a reduction in the American output, and of this one sees little sign at present; in fact, it is openly stated that many American producers cannot make a profit unless their capacity is exploited to the utmost. This may be true in some cases, but one knows quite well that in other cases there is a very big profit on copper production even when the selling price is below 14 cents per pound. The market for old non-ferrous metals remains very quiet. The dealers in this market are offering £45 per ton for good gun-metal scrap and £36 for yellow brass scrap. The latter compares with £45 to £47 for brass ingots (60/40) and £55 to £57 for brass ingots (70/30). Dealers' prices for old lead and old zinc are very much nearer the intrinsic value of that class of scrap. There seems to be some doubt growing in the market for tin as to the soundness of the present position. There is, of course, no doubt that the statistical position is good, but some uncertainty exists as to whether sales of the reserve stock in the East may not be too great. Doubts about the future of prices were more or less indicated by the much greater tendency to sell for forward delivery, which brought about a substantial difference between spot and forward prices. The market for lead does not show any particular change, and the general opinion is that the prices are likely to be maintained for some time. It has, of course, to be admitted that lead prices are high, but that has been the case for a long time. There seems to be a very uncertain feeling in the market for spelter. Some people assume that if a settlement of the Ruhr question is arrived at offerings of German spelter will develop, which will counteract the effect of a large demand from the galvanisers. Spelter prices are, however, fairly high already.

Pig Iron.

The market here for pig iron, both foundry and forge qualities, remains very quiet, but there are reports coming through from other districts about a better feeling. This may be a temporary phase caused by the expectation of some revival in the autumn, for the belief in autumn and spring revivals is hard to kill. At any rate, there is no visible improvement yet in Manchester, and trade in pig iron is for small lots and for prompt delivery. The prices here are still based on 92s. 6d. at the furnaces for No. 3 Derbyshire iron and on 90s. for Northamptonshire. Practically these figures mean about 100s. per ton for foundry iron delivered free in the Manchester district, and it seems very difficult to get the cost of iron below this figure so long as fuel remains dear. The return of the German contribution to the fuel supplies of Europe might lead to lower prices, but this is still too problematical to calculate upon. Meantime the foundry trade here languishes, as is clear from the much smaller consumption of pig iron and scrap in the district. There are few large buyers of forge iron now and the price seems to vary from 87s. 6d. to 90s. delivered to the Lancashire forges, or, say, 10s. to 12s. 6d. below the selling price of foundry. Of course, the furnaces avoid making this quality so far as it is possible to do so. Scotch iron is unchanged and the demand for it is poor. Prices here seem to range from 112s. 6d. to 117s. 6d., the latter price corresponding with the figures quoted from Scotland.

Finished Material.

The prices here for manufactured steel remain at £9 5s. to £9 10s. per ton for joists and angles, £10 to £10 5s. for plates. It is said that amongst the North Eastern works there is now less tendency to cut the prices, and to this extent it may perhaps be said that the market is better; but the whole range of prices for manufactured steel is utterly unprofitable. Japanese business is talked of, and some has been done already with continental works. The demand here for finished iron is small, and buyers usually attribute this to the high prices required by the Lancashire makers. Where steel will do as well—as, for instance, in the case of railings—naturally the business is lost to the iron manufacturer.

Scrap.

Dealers here do not make any change in their prices for scrap, but business is very much restricted. For textile machinery cast scrap 85s. per ton is quoted, for heavy wrought scrap from 75s. to 77s. 6d. and sometimes up to 80s. delivered. The value of steel melting scrap on trucks at a station in Lancashire is barely 65s. per ton.

BARROW-IN-FURNESS, Thursday.

Hematite.

The hematite iron trade is perhaps a little better than it was last week, and there being a better prospect in certain of the steel departments, the chance of a reduction in the output of iron is unlikely. Although the market is dull, the North Lonsdale Iron Company has put another furnace in blast. Such a thing would appear to be a contradiction of the reported state of trade, but the North Lonsdale works at Ulverston have a very steady trade moving along old channels, and the increase of output signifies that the orders held are increasing in bulk, which is not a bad sign, generally speaking. But trade on the whole is still dull, with no immediate chance of improving to any great extent. There are faint signs of returning activity, but they will take some time to achieve solid substance. Fuel is still a factor which operates against the cheap iron which customers are asking for.

Iron Ore.

There is little change in the iron ore trade in this district and very little is going out. Many miners are out of work and others who are employed are on short time. Foreign ore is not arriving in quantity, nor is it likely to do so until the iron trade revives.

Steel.

The steel trade is still quiet, and such orders as are on the market for competition are at low prices, which barely leave a margin. The Workington mills have secured an order for 10,000 tons of rails for the Gold Coast and also 8000 tons of sleepers. They have also to make the fish-plates in connection with the order. This will provide work for some weeks and will absorb iron which otherwise would go into stock. The Barrow rail mills are still engaged, as also is the merchant mill, but it is not known how long they will be able to keep going. Orders are possible in the near future. The hoop mills at Barrow are fully employed and are likely to be so for some time, as also are the small section mills.

LATER.

Owing to the slackness in the steel trade, notices were posted on Wednesday that the Barrow Steel Works would cease operations on Thursday night. The hoop works continue engaged and also the steel foundries. There are two blast-furnaces in operation and these will continue at work.

SHEFFIELD.

(From our own Correspondent.)

An Improving Tone.

AFTER the long and unbroken series of reports that it has been necessary to write about the poverty of new orders for basic steel, it is pleasing to be able to record, this week, that there are signs of a change for the better. Several substantial orders for billets have been placed, and, although it would be unwise to draw any general conclusion from this fact, it is enough to raise hopes. The position as a whole shows no improvement, but rather the reverse, and the number of unemployed in the various steel branches to-day is fully 2000 more than it was a month ago. At the same time, the tone is improving, and a more cheerful view is taken of the future. About three-quarters of the basic steel furnaces in the district are now at work. In the acid steel department, however, there is not employment for more than a quarter of the city's plant.

South American Orders.

The railway steel departments continue to be among the most active in Sheffield. Good orders have recently been received for material and stores for South America, and the axle, tire and spring plants are probably doing better than any other important branch of the steel industry. Even here, however, there is not enough work on hand to call for full time operation, and, as idle machinery means financial loss, the present rate of production is not as remunerative as could be desired. Business in crucible steel is still of very limited dimensions, and only a few firms are at all well placed. The orders coming forward, although numerous, are of a small, hand-to-mouth character, and are very unevenly distributed. There is a poor demand for high-speed steel cutters, including twist drills, in which branch strong French competition is a growing feature. So far as ordinary steel drills are concerned, the Germans are severe rivals; in fact, they have been doing the bulk of the trade up to the present time. The tool trades are somewhat better. Sheffield is sending out a considerable weight of tools of many descriptions, especially mining and civil engineering tools. A few of the file-making firms are doing quite well, and an improvement is to be noted in this trade, although its general condition is still depressed.

Cutlery and Plate.

The position in the cutlery and plate trades appears to be mending slightly, chiefly because of the placing of orders for the coming Christmas season. Buying should be stimulated by the fact that prices generally are much lower than those of a year ago. For stainless knives, small cases of plated goods, spoons and forks, there is a good demand; but the amount of hollow-ware called for is small. A cheering feature of the situation is a sharp decline in German competition, not only in cutlery, but in all descriptions of tools and hardware goods. Germany can no longer send over certain lines which have been selling in this country in very large quantities, and, while some of our merchants still have good stocks on hand, others have run short. Any continued inability on the part of Germany to turn out cutlery and tools on an extensive scale will be to the advantage of Sheffield in both home and foreign markets. The extent to which overseas sales of cutlery, outside the Empire, have shrunk, is shown by the fact that more than 75 per cent. of our exports at present go to the various British Dominions. Another interesting point is that there are signs of a revival in the old-fashioned razor trade, which has been very much under a cloud for a long time. The safety razor has done the old trade great injury, but several firms express a belief that the old type is coming back into favour, and one of them is working at full pressure and is increasing its number of grinders.

Effect of the Earthquake.

The Sheffield wireless station was put to an important national use last week, when Sir Arthur Balfour, President of the Associated Chambers of Commerce, broadcasted a speech on the Japanese disaster and its effect on local industries. "It is not yet appreciated," he said, "how deeply the rolling mills, forges and general trade of Sheffield are affected, as not only was a considerable business in iron and steel done direct with Japan, but Japanese orders for machinery, plant, ships, guns and armour plate, and all kinds of engineering products placed in other parts of England, filtered through to Sheffield in the form of steel and tool requirements." Speaking of the future, he said "It is true that when the Japanese Loan is floated, and they commence seriously to rebuild, it will make a certain amount of trade, but the moment that is finished a period of convalescence will come into force, and I fear that for several years Japan will not produce that international trade which we are at the present moment needing so seriously."

Mining Progress.

The continued progress of the mining industry in the district is demonstrated by the reports of the Sheepbridge and Staveley Coal and Iron Companies, just issued. The former states that the sinking of the new pit at Glapwell colliery has made good progress, and has now reached a depth of 330 yards. The sidings and other works connected with the new colliery are proceeding satisfactorily, and it is expected that coal winding will be begun within the next twelve months. The Staveley Company states that satisfactory progress has been made with the sinking of the Do-Well colliery, and it is hoped to reach coal towards the middle of next year. A new coal washer at this colliery is already at work. Operations are proceeding rapidly at the new Firbeck Main colliery, in which the two companies named, and a third, are jointly concerned. The Sheepbridge Company has increased its holding in the Firbeck concern to 200,000 shares; the Staveley Company has subscribed for 400,000, and the Dinnington Main Coal Company has taken a further 31,000.

Other Developments.

Besides carrying on the iron and coal trades both Sheepbridge and Staveley are engaged in a variety of other industries, which they are constantly developing. A new plant for breaking slag and making tar-macadam has been erected at the Sheepbridge Works. In conjunction with Stokes Castings, Limited, of Mansfield, a company, entitled the Sheepbridge Stokes Centrifugal Castings Company, Limited, has been formed to purchase the patent rights and business in the manufacture of centrifugal castings, and a new plant is in course of erection at Sheepbridge for that purpose. The development of the new ironstone field at Roxby, in Lincolnshire, is approaching completion, and an area of 186 acres of surface near the Sheepbridge Company's ironstone mine at Desborough has been purchased. Among other chemical developments carried out by the Staveley Company, a plant for the manufacture of bleaching powder and caustic soda has been completed, as well as a new sulphuric acid plant, and both are working satisfactorily. Both companies are taking active measures to increase the housing accommodation in their districts.

Orders for Haulage Drums.

David Ashton and Co., Limited, of Sheffield, are achieving considerable success with their patented internally-geared haulage drums. These appliances were brought before the mining world at the recent International Mining Exhibition, and since then the firm has received a large number of orders for electric, compressed air and oil-driven gears. At present it has on order single drum, main and tail and endless rope sets, ranging from 15 to 40 horse-power, for many companies.

NORTH OF ENGLAND.

(From our own Correspondent.)

New Hope in Shipyard Dispute.

THERE is a growing feeling in Northern industrial circles that everything possible must be done to bring to an end the boilermakers' dispute, which has now lasted twenty weeks, and is having a most disastrous effect upon shipbuilding, ship repairing and other industries. With the desired object in view, the Lord Mayor of Newcastle convened a meeting of North-East Coast mayors on Tuesday to endeavour, if possible, to bring the parties together once more and to find a way to a settlement. Confident hopes are entertained regarding this peace move. The outlook in the shipbuilding industry is certainly improving. It is learned that there are a number of inquiries abroad for new vessels, several of large size, including a considerable number of oil-carrying steamers which are said to be required urgently. Some firms have secured contracts, notably the Palmer Shipbuilding and Iron Company, Jarrow and Hepburn, which has taken several orders that have been confirmed, and all this work, in addition to that on vessels suspended owing to the dispute, could be started if the men returned to work. There are grounds for stating that other firms have booked orders, and that more would be forthcoming if shipowners were assured that work could be proceeded with.

Cleveland Iron Trade.

The Cleveland pig iron trade shows signs of improvement. Both from home and foreign consumers there are quite a number of good inquiries circulating, and whilst only a proportion of these have matured, makers report that a fairly satisfactory volume of business has been done on home and foreign account. A gratifying feature is the inquiry for deliveries up to the end of the year. A number of consumers have this week indicated a desire to contract for forward deliveries, and this is regarded as evidence that consumers are at last becoming convinced that the market has touched bottom. Another furnace which has been producing iron for steel making is being put out of operation. There is, however, a big stock of iron to be disposed of. The only change in prices recorded this week is a reduction of 6d. per ton in the value of No. 3 Cleveland pig iron, which is now on offer at 97s. per ton. Other quotations are:—No. 1, 102s. 6d.; No. 4 foundry, 92s. 6d.; and No. 4 forge, 90s.

Hematite Pig Iron.

A firmer tone characterises the East Coast hematite pig iron trade, and with prices steady there is a little more freedom among consumers, who have been placing fairly satisfactory orders. The foreign demand has improved considerably, and some good orders have been booked. The general market quotation for mixed numbers is 99s., but some makers ask up to 100s. per ton.

Ironmaking Materials.

Owing to the protracted strike at Bilbao, stocks

of Rubio ore are understood to have run very low, and it is difficult to arrange shipments. Best Rubio is firmer at 23s. per ton c.i.f. Tees. Ironmasters are still paying anything from 40s. to 41s. 6d. per ton for their coke delivered at the works.

Manufactured Iron and Steel.

The manufactured iron and steel trade displays little animation, nor is it expected to do so until the shipyards are at work again. The only branch really active is the sheet trade, and makers have booked some large orders. The Japanese disaster has increased the pressure for galvanised sheets, but orders for heavy steel for the construction of the devastated areas have not yet been placed, though this district hopes to get a fair share of the business. Galvanised corrugated sheets, 24-gauge, are now at a minimum of £19 per ton, but other steel prices are unchanged.

The Coal Trade.

There are few, if any, items of more than passing interest in the Northern coal trade. Everything is quiet and dull, and for the most part it is a question of marking time. There is nothing at all under treaty of a speculative nature. The ideas of producers and merchants seem to be divergent as to future probabilities of price movements. The collieries take the view that prices will not come down any further, while the merchants and exporters are of the opinion that at current rates the foreigners will not buy and are therefore awaiting a further reduction in prices before attempting to book ahead. At all events, the collieries, despite many concerted efforts to bear the market, are maintaining their quotations moderately well. The weakening factor in the situation is the absence of any considerable or pressing inquiry from abroad. The German inquiry is only slow and gives no indication of an early expansion, while for Scandinavia and also the Mediterranean nothing much is possible under present conditions. The colliery positions, however, seem to be more or less satisfactory for the next two or three weeks, most of them being fairly well stemmed for that period. Northumberland steam coals are steady for prompt or early next month. Further forward there is very little attempted. Second steams are also moderately well off for stems and are steady. This applies equally to smalls of every sort. Best brands of Durham gas coals are fairly firm, but secondary sorts are possible at a discount. There is a slightly better tone in coking of every brand, while bunkers are barely steady. The coke market is quiet, but nominally unchanged either for foundry or gas coke.

SCOTLAND.

(From our own Correspondent.)

No Progress.

HOME markets generally are still unprogressive and are not likely to make any step forward until the shipyard dispute is over. It is felt that with the boilermakers' trouble at an end trade at home would soon show considerable improvement. During the current year many orders have been placed for ships and machinery, and though a number may have since been cancelled, there seems little doubt that the work still on the books is sufficient to produce a fair measure of activity in the shipbuilding and allied trades. In fact, it is said that in one or two Clyde areas there is more work on hand than has been the case for a number of years. Meanwhile activities are being held up through the action of a section of the shipyard workers and all trades are affected. Producers, naturally, have turned to foreign markets to alleviate this lack of work, but so far their efforts have met with very indifferent success. Few works, if any, are fully employed, and under such conditions makers find difficulty in quoting prices calculated to gain contracts and still leave a fair margin of profit. At any rate, they complain that the terms offered by foreign buyers are in many cases unremunerative. Latest reports on export indicate easy prices, but less inquiry and a greater difficulty in securing even a small measure of business.

Pig Iron Inactive.

Although it is said a better tone is apparent in the pig iron market, it is yet difficult to note any sign of an expansion in business. The cheaper tendency of prices may have created a more hopeful feeling, but the turnover has not benefited to any appreciable extent. The home demand is extremely limited and export orders are comparatively small and irregular. Mention has been made of consumers asking terms for deliveries some time ahead, and this is perhaps a hopeful sign.

Steel—Quiet Apart from Sheets.

No change can be reported in the steel situation. Inquiries for plates and sections still leave a great deal to be desired, and with each succeeding week the effect of the boilermakers' dispute on the trade is brought home more vividly. Recent reductions in price have had hardly any improving effect and the majority of the works have very little work on hand. The continued demand for sheets of the lighter gauges still supplies almost the only cheerful feature of the steel industry. Makers, too, anticipate an early expansion in the demand for both black and galvanised sheets for the Far East. In the meantime, however, a larger turnover in sheets of the heavier gauges would be welcome. Prices are unchanged.

Iron Trade Conditions.

So far there are no signs of a recovery in bar iron and the position is most unsatisfactory. The home demand could hardly be lower, either for iron or re-rolled steel bars. Export would seem to have a trifle more movement, but manufacturers are not enamoured of the prices offered. Iron bars for home delivery are still quoted £12 per ton, Crown quality, while exporters offer something in the region of £11 per ton for similar material. There is a better inquiry for wrought iron products. Supplies are not too plentiful, however. The scrap trade is lifeless.

Coal.

No marked change is apparent in the Scotch coal trade. In the Lanarkshire district the collieries continue to feel the lack of orders for round coal, despite better demands for ells, and outputs are being regulated, thereby necessitating a resort to short time. Ayrshire is similarly placed, but the collieries there anticipate an increasing turnover for the Irish market. Washed nuts are still busy and maintain a firm attitude. A steady business is being done in both Fifeshire and the Lothians. Demands from Germany and near continental destinations have been fairly heavy and shipments are improving, more especially from Fifeshire. The Lothian collieries have good orders for practically all descriptions of round coal. Aggregate shipments for the past week amounted to 350,242 tons, against 345,528 tons in the preceding week and 337,750 tons in the same week last year. The home market is dull owing to the extremely poor demand for industrial supplies. Any expansion noticeable is in house coal. Quotations show little change.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

THERE has been no improvement in the general state of the steam coal trade during the past week, and there are, unfortunately, no signs at the moment of any immediate change for the better. The demand from abroad has been on an extremely limited scale, and what buying has taken place has been on the basis of such low prices that only firms which hold coals on low contract prices can accept the business and make any profit, if, indeed, they actually do so. As a matter of fact, many firms with contract coals have had the greatest difficulty to find an outlet at all, and therefore have been very backward in nominating their tonnage to the collieries. The result has been that quite a number of the collieries have been in none too good a position, and they have been hard pressed to get the regular clearance of their wagons in order to enable them to keep the pits working without interruption. To avoid pit stoppages collieries have been only too ready to make concessions in their prices in order to get the quick clearance of their wagons, and these concessions have amounted to 1s. or 1s. 6d. per ton, but for forward business colliery salesmen are holding out for higher figures, and in this connection it is interesting to note that collieries are indicating as much as 30s. for best Admiralty large, and 27s. 6d. for second qualities for delivery over the whole of next year. This certainly shows a very optimistic view regarding the future as buyers' ideas are very much lower, and if they are called to pay anything like these figures, it is pretty certain that the majority of buyers would prefer to run the market in the full expectation that they would be able to do much better. It is, however, usually the case that about this time buyers do their utmost to bear the market with the view of making their arrangements for supplies for the following year on the most advantageous terms. Coal owners at the moment are not in any hurry to contract for coals over 1924, and are quite content to wait in the hope that during the next month or so the tone of the market will be better than it is now. Meanwhile, on the labour side, there are very plain indications that the workmen are dissatisfied with the returns of the recent audit under which they get an advance of 3.85 per cent. upon the wage rate of July and August. Their leaders had expected to see a much higher rise, something in the neighbourhood of 15 per cent., and they are disappointed. The result is that in some of the districts there is a disposition to call for a full inquiry into the Custom House figures and those shown in the ascertainment for the months of May and June last, on which the advance for this month and next is based. The Executive Committee has been asked to press for such an inquiry.

Trade Outlook in West Wales.

In the steel and tin-plate industry there is a disposition to regard the outlook in a favourable light, and at Llanelly it is interesting to note that both the steel works operations are now in full swing. Quite recently three additional furnaces have been lighted up at the Llanelly Steel Company's works, bringing up the number to ten out of twelve furnaces. The two bar mills at these works are also in full operation. Progress is also reported to have been made at Richard Thomas Company's South Wales steel works, at which seven out of ten furnaces are being worked. In the case of tin-plate works in this locality the prospects are regarded as very good, and it is understood that in some instances extremely satisfactory orders have been booked up. The Emu spelter works at Skewen are also to be re-opened shortly. An attempt to open them during the war was made, but the difficulty of securing the ore necessary made the proposal impracticable.

Bridging the Severn.

The question of erecting a bridge over the river Severn has figured prominently for some time past in this district, and on Saturday last an important conference of delegates representing various local bodies in South Wales and Gloucestershire was held at Chepstow. This conference, for the purpose of furthering the scheme of constructing a road bridge from Beachley to Aust Cliff, was regarded as extremely successful. The advantage of carrying out such a project from the point of view of reducing the mileage between England and South Wales, facilitating trade, relieving unemployment, &c., was fully dwelt upon, and a deputation was appointed to interview the Great Western Railway and the Ministry of Transport and Labour. The statement was made at the conference that the Severn Tunnel was doomed as it was inadequate to deal with traffic even in normal times, and that this fact was appreciated by no one more than the Great Western Railway. Since the conference a semi-official statement, *i.e.*, a statement by an un-named official of the company has appeared, from which it is made clear that the Great Western Railway Company has no intention to scrap the Severn Tunnel, and that the limit of the capacity of the tunnel has not been reached. It is questioned whether an adequate road bridge could be erected at £1,500,000, which was the estimate of the expert, and, further, seeing that its construction would mean direct competition with the Great Western Railway Company, doubts are expressed whether the latter would have any object or inclination to further the proposal of a road bridge. It will be interesting to see what develops from the proposed interview with the company.

Current Business.

The steam coal market has been very featureless during the past week, as the inquiry from abroad has been meagre in the extreme. There seems to be no disposition to operate at all, and it is safe to say that the bulk of the shipments being made at the present time are coals contracted for some time ago. Values of practically all descriptions have shown marked irregularity for the reason that they have depended upon the individual position of collieries. Many of the latter have been in an unenvious situation from the point of view of empty wagons, and this has compelled them to make substantial reductions in their ideas regarding prices for spot coals. Best Admiralty large have varied from 28s. to 30s., and second qualities from 26s. 6d. to 28s., while Monmouthshire large coals have shown a rather wide margin. Smalls of the inferior classes have been plentiful, but some of the superior qualities have been on the scarce side in view of the fact that some of the collieries have been working somewhat irregularly, and the demand for bunkers has been fairly good. Coke and patent fuel remain without much change, but in the anthracite coal section the tone is not quite so good, the settlement of the strike in the American coalfield having adversely affected the inquiry from this district.

CATALOGUES.

HANS RENOLD, Limited, Didsbury, Manchester.—Pamphlet Notes on the selection of chain gear.

FUEL RECOVERY SYNDICATE, Limited, 40, Westminster Palace-gardens, Victoria-street, S.W. 1. Folder. "Boiler tubes saved by 'Argil' ferrules."

AUTOMATIC AND ELECTRIC FURNACES, Limited, 173–175, Farringdon-road, E.C. 1.—Leaflet. Wild-Barfield patented stainless steel hardening equipment.

THE DURA MANUFACTURING COMPANY, Limited, 2, Newhall-street, Birmingham.—Priced leaflet dealing with "Cobaltcrom" valves for motor cars and motor cycles.

ADAM HILGER, Limited, 75A, Camden-road, N.W. 1.—Pamphlet. Professor Coker's apparatus for determining the distribution of stress in structural and machine members.

HYATT, Limited, 56, Victoria-street, S.W. 1.—Pamphlet. Applications of ball and roller bearings to automobiles. Pamphlet. The industrial applications of ball and roller bearings.

MANLOVE, ALLIOTT AND CO., Limited, Nottingham.—Catalogue 512. Manlove's hydro-extractors or centrifugals. Supplement to Circular 819. Automatic control valves for hydraulic presses.

HOLLINGS AND GUEST, Limited, Thimble Mill-lane, Birmingham.—List No. A 107. Guest's all-metal bundling press for waste paper. List No. A 114. Oil mill machinery. Complete plants suitable for crushing and extracting oils.

MARSHALL, SONS AND CO., Limited, Gainsborough.—Publication No. 1355. Marshall's boilers of the Cornish, Lancashire and allied types and accessories. Publication 1362. Horizontal steam engines, Class O, with suitable boilers, specially designed for oil well drilling. Pamphlet of testimonials from representative users of "Marshall" road rollers.

LAUNCHES AND TRIAL TRIPS.

BLUESTONE, self-trimming collier; built by Swan, Hunter and Wigham Richardson, Limited, to the order of the Crete Shipping Company, Limited; dimensions, 235ft. by 36ft. by 17ft. 6in.; 1760 tons deadweight. Engines, triple-expansion; constructed by the builders; launch, September 8th.

T.I.C. No. 23, steel screw hopper barge; built by Palmer's Shipbuilding and Iron Company; to the order of the Tyne Improvement Commission; dimensions, 175ft. by 32ft. 2in. by 14ft. 6in.; to carry about 800 tons. Engines, direct-acting surface-condensing triple-expansion, pressure 160 lb.; constructed by the builders; launch, September 13th.

INSTITUTE OF TRANSPORT.—The Council of the Institute of Transport has bestowed its Triennial Gold Medal upon Mr. Dixon H. Davies (member) for his paper on "The Finance of the Modern Highway: A Problem and a Solution," and has made awards in respect of the session 1922–23, as under:—Railway (Operating) Gold Medal, to Sir Philip Dawson, for paper on "The Financial Investigation of the Prospects of Railway Electrification"; Railway (Engineering) Gold Medal, to Sir Robert Hadfield, D.Sc., F.R.S., for paper on "Modern Trackwork and Its Importance"; Road Transport (Passenger) Gold Medal, to Mr. Sidney E. Garcke (member), for paper on "Passenger Transport by Road in Rural Areas"; Aviation Gold Medal, to Major-General Sir W. Sefton Brancker, K.C.B. (member), for paper on "Air Transport"; Water Transport Gold Medal, to Dr. Bryson Cunningham, D.Sc., for paper on "Cargo Handling at Ports: British and American Methods Compared"; Dock and Harbour Gold Medal, to Mr. Alfred H. Roberts (member), for paper on the subject selected by the donor, namely, "The Most Expeditious and Economical Method of Handling Goods at the Quay Side"; Institute Silver (Graduate) Medal, to Mr. E. W. Bayliss, for paper on "Tramways: Their Scope and Object, &c."; Institute Silver (Student) Medal, to Mr. H. A. Groome, for paper on "The Science and Significance of Compiling Accurate Time-tables"; *Modern Transport* Premium, to Mr. A. Wardle (graduate), for paper on "Historical Development of the Railway Goods Rate." The medals and premium will be presented at the meeting of the Institute to be held in the Lecture Theatre of the Institution of Electrical Engineers, Victoria Embankment, London, W.C., on Monday, October 1st, on which occasion Sir Joseph G. Broodbank will be inducted as President for the ensuing year, and will deliver his inaugural address.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	26/-
(1) Spanish	23/-
(1) N. African	23/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	23/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	5 5 0	—
No. 1 Foundry	5 5 0	—
No. 3 Foundry	5 0 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 19 0	5 0 0
No. 1	4 19 6	5 1 6
Cleveland—		
No. 1	5 2 6	5 2 6
Silicious Iron	5 2 6	5 2 6
No. 3 G.M.B.	4 17 0	4 17 0
No. 4 Foundry	4 12 6	4 12 6
No. 4 Forge	4 10 0	4 10 0
Mottled	4 10 0	4 10 0
White	4 10 0	4 10 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge*	—	—
„ „ Foundry	4 15 0 to 5 0 0	
(3) Northampton—		
Foundry No. 3	4 10 0 to 4 12 6	
„ Forge	4 2 6	—
(3) Derbyshire—		
No. 3 Foundry	4 12 6 to 4 13 6	
Forge	4 0 0 to 4 5 0	
(3) Lincolnshire—		
Basic	4 13 0	—
No. 3 Foundry	4 14 0	—
No. 4 Forge	4 12 0	—
(4) N.W. COAST—		
N. Lancs and Cum.—		
Hematite Mixed Nos.	5 12 6	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	12 0 0	—
Best „	—	—
N.E. COAST—		
Crown Bars	12 0 0	—
Tees	10 0 0	—
LANCS.—		
Crown Bars	12 0 0	—
Second Quality Bars	11 5 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	12 0 0	—
Best „	13 0 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	12 0 0 to 12 10 0	
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	10 15 0	—
Gas Tube Strip	12 10 0 to 12 12 6	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	13 0 0	—
Ship Plates, ¾in. and up	10 0 0	—
Sections	9 15 0	—
Steel Sheets, 3/16in. to ¼in.	12 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	18 17 6

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	9 15 0	—
Angles	9 5 0	—
Boiler Plates	13 0 0	—
Joists	9 10 0	—
Heavy Rails	9 10 0	—
Fish-plates	12 10 0	—
Channels	9 5 0	—
Hard Billets	10 5 0	—
Soft Billets	9 0 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 10 0†	—
Light „	11 0 0†	—
Billets	8 0 0†	—
MANCHESTER—		
Bars (Round)	10 5 0 to 10 10 0	
„ (others)	10 0 0 to 10 2 6	
Hoops (Best)	15 5 0	15 0 0
„ (Soft Steel)	13 15 0	13 10 0
Plates	9 15 0 to 10 0 0	
„ (Lancs. Boiler)	13 10 0	—
SHEFFIELD—		
Siemens Acid Billets	12 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	10 5 0	—
Intermediate Basic	10 0 0	—
Soft Basic	8 0 0	—
Hoops	12 10 0	—
Soft Wire Rods	12 0 0	—
MIDLANDS—		
Small Rolled Bars	9 10 0 to 9 15 0	
Billets and Sheet-bars	7 15 0 to 8 5 0	
Gas Tube Strip	10 10 0 to 11 0 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	19 0 0	
Angles	9 10 0	—
Joists	9 10 0	—
Tees	10 10 0	—
Bridge and Tank Plates	10 0 0 to 10 5 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	23/1½ to 23/3
Block Tin (cash)	197 5 0
„ (three months)	197 15 0
Copper (cash)	62 2 6
„ (three months)	62 15 0
Spanish Lead (cash)	25 7 6
„ (three months)	25 0 0
Spelter (cash)	32 15 0
„ (three months)	32 7 6
MANCHESTER—	
Copper, Best Selected Ingots	66 15 0
„ Electrolytic	68 5 0
„ Strong Sheets	96 0 0
„ Tubes	0 1 1½
Brass Tubes	0 1 0
„ Condenser	0 1 2½
Lead, English	26 15 0
„ Foreign	25 5 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit
Tungsten Metal Powder	1/10 per lb.	
Ferro Tungsten	1/5½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	10/6
„ 6 p.c. to 8 p.c. „	£21 0 0	8/-
„ 8 p.c. to 10 p.c. „	£20 0 0	8/-
„ Specially Refined		
„ Max. 2 p.c. carbon	£50 0 0	18/-
„ „ 1 p.c. „	£60 0 0	21/-
„ „ 0.75 p.c. carbon	£70 0 0	22/6
„ carbon free	1/6 per lb.	
Metallic Chromium	4/3 per lb.	
Ferro Manganese (per ton)	£18 for home, £20 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 to £11 15 0	scale 5/- per unit
„ „ 75 p.c.	£20 0 0	scale 6/- per unit
„ Vanadium	17/- per lb.	
„ Molybdenum	9/6 per lb.	
„ Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£130	
Cobalt	11/6 per lb.	
Aluminium (per ton)	£82 to £100	

(British Official.)

FUELS.

	Export.
SCOTLAND.	
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	19/3
„ „ Ell	21/-
„ „ Splint	21/6 to 24/-
„ „ Trebles	24/6
„ „ Doubles	23/6
„ „ Singles	22/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	19/3
„ „ Splint	21/6
„ „ Trebles	24/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	19/6 to 21/-
Screened Navigation	27/6
Trebles	27/
Doubles	23/9
Singles	22/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	21/9
Secondary Steam	20/3
Trebles	26/-
Doubles	24/-
Singles	22/6
ENGLAND.	
(8) N.W. COAST—	
Steams	31/6
Household	46/8 to 57/6
Coke	46/-
NORTHUMBERLAND—	
Best Steams	24/- to 24/6
Second Steams	22/6 to 23/-
Steam Smalls	16/- to 17/-
Unscreened	20/6
Household	25/- to 28/-
DURHAM—	
Best Gas	24/- to 25/-
Second	22/6 to 23/6
Household	25/- to 28/-
Foundry Coke	50/- to 52/6
SHEFFIELD	Inland.
Best Hand-picked Branch	29/6 to 31/- —
Barnsley Best Silkstone	26/6 to 28/- —
Derbyshire Best Brights	25/- to 27/- —
„ „ House	22/6 to 23/6 —
„ „ Large Nuts	20/- to 21/6 —
„ „ Small „	15/- to 16/- —
Yorkshire Hards	21/- to 23/- —
Derbyshire „	20/- to 22/- —
Rough Slacks	11/6 to 13/6 —
Nutty „	10/- to 12/- —
Smalls	7/- to 9/- —
Blast-furnace Coke (Inland)	34/- to 35/-
„ „ (Export)	f.o.b. 42/- to 43/-
CARDIFF—	(9) SOUTH WALES.
Steam Coals :	
Best Smokeless Large	28/- to 29/-
Second „ „	26/6 to 27/6
Best Dry Large	28/6 to 29/6
Ordinary Dry Large	26/6 to 27/6
Best Black Vein Large	27/6 to 28/-
Western Valley „	27/- to 28/-
Best Eastern Valley Large	26/6 to 27/6
Ordinary „ „	25/- to 26/-
Best Steam Smalls	19/- to 20/-
Ordinary „	18/- to 19/-
Washed Nuts	27/6 to 32/6
No. 3 Rhondda Large	30/- to 31/-
„ „ Smalls	24/- to 25/-
No. 2 „ Large	23/- to 24/-
„ „ Through	18/6 to 20/6
„ „ Smalls	15/- to 16/-
Coke (export)	42/6 to 47/6
Patent Fuel	30/- to 33/-
Pitwood (ex ship)	29/6 to 30/6
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	50/- to 52/6
Seconds	40/- to 42/6
Red Vein	32/6 to 35/-
Machine-made Cobbles	60/- to 62/6
Nuts	60/- to 62/6
Beans	45/- to 47/6
Peas	27/6 to 30/-
Breaker Duff	12/6 to 13/
Rubbly Culm	15/- to 16/-
Steam Coals :	
Large	25/- to 26/-
Seconds	22/- to 23/-
Smalls	14/- to 16/-
Cargo Through	20/- to 22/6

(1) Delivered. (2) Not Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow.

(8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

* Quotations extremely high and nominal. † Latest quotations available.

French Engineering Notes.

(From our Correspondent in Paris.)

Foundry Congress.

THE Foundry Congress that was held during the past week at the Ecole des Arts et Metiers was attended by representatives of the ironfoundry industry from a number of countries, including Great Britain, the United States, Belgium, Czecho-Slovakia and Spain, the latter country being represented by a particularly large number of delegates. The papers read were mainly of a practical character. A communication on the methods of testing iron castings was followed by a long discussion, and it was made clear that a distinction must be made between tests of cast iron and tests of castings, as the former could give no indication of the quality of the castings themselves. It was proposed that each country should appoint a committee to go fully into this question of tests and submit to a future Congress suggestions for trustworthy methods which would be satisfactory alike to blast-furnace proprietors, founders and customers. The strength of cast iron was dealt with by one of the Spanish delegates, who was of the opinion that the factor of safety usually employed was too high, and could be conveniently reduced, but this view did not meet with the approval of the majority of members, who believed that any considerable reduction in the factor could only be brought about safely by a close collaboration between founders and their customers; that was to say, the founder must know exactly what the customer required, and must be able to profit from experience in the behaviour of the castings. As a matter of fact, knowledge of the strength of cast iron is deficient, for, as Mr. Adamson, of Sheffield, pointed out, the metal is subjected to many influences, not only in its molten state in the blast-furnace, but also in the cooling. The production of malleable iron castings was dealt with by M. Gailly, of Charleville, who referred to the considerable progress made in France in this branch of the foundry art, which he attributed, for the most part, to the methods introduced from the United States. French producers of malleable iron castings fully acknowledged their indebtedness to the Americans. The papers and discussions showed that ironfoundry work was still conducted on more or less trial-and-error methods, although considerable advance had been made on the scientific side of the industry. Several of the papers indicating new lines of research could not be thoroughly dealt with in the short time at the disposal of the members. One immediate result of the Congress was the formation of a committee to carry out arrangements for the constitution of an Association of Malleable Ironfounders, which will exercise a control over the manufacture of malleable iron castings, in the sense of improving foundry methods and classifying the products. It was also pointed out that international research work was impeded by the want of suitable translations of foundry terms, and it was therefore decided to undertake the preparation of a dictionary of terms relating to the foundry industry.

Trade Opportunities.

The steady improvement in the value of the franc last week gave general satisfaction in providing evidence of increased confidence in the stability of the financial position, but it was, nevertheless, regarded as carrying some danger if the improvement should continue too rapidly, especially at a time when the iron and steel trades are in a particularly critical position, on account of the exaggerated price and the deficient supply of coke. While the price of coke is rapidly advancing, there is a general feeling that the Ruhr problem is approaching a solution, and the belief that there may be an early favourable change in the situation is causing consumers to hold back orders, while manufacturers themselves are not keen to take new contracts. The advancing prices of raw material have been accompanied by an increase in charges generally, which have appreciably augmented manufacturing costs. The improvement in the franc, therefore, has further complicated the situation of manufacturers, who can hardly expect, for a long time yet, to see their costs come down to a proportionate extent, and it is freely stated that if sterling should recede to anywhere near 65f., British firms will find themselves in a more favourable position for doing business than producers in this country. For that reason, manufacturers would much prefer to see the franc improve in progressive stages over a period sufficiently long to permit of business adjusting itself to the new conditions.

Dehydrating Alcohol.

Now that the processes for dehydrating alcohol have been so far improved as to open up the prospect of their becoming commercially successful, in the sense that it will be possible to produce alcohol at 95 deg. in large quantities and at a sufficiently low cost to permit of its being mixed with petrol as a motor fuel, it has become necessary to find some means of preventing dehydrated alcohol from absorbing moisture from the air while stored in receptacles or tanks. Information concerning a method of attaining that end, experimented with by M. Paul Dumanois, has been communicated to the Académie des Sciences. The process consists in placing the storage tank in communication with the air by means of a chamber with a number of baffle plates and containing a quantity of dehydrated alcohol. The air in its passage to the tank is kept in contact with the alcohol sufficiently long to allow of the spirit absorbing the moisture, and means are employed to maintain the alcohol at the required level.

Commercial Aeroplanes.

A new plan for the development of the commercial aeroplane has been inaugurated this week in the trials carried out by the Ministry of Aviation, when the machines were required to travel between Le Bourget and Metz until they had accomplished a total distance of 3000 kilomns., with intermediate specified landings. The factors taken into account for classification purposes were the load carried per square metre of plane surface, the engine power, the speed and the fuel consumption for the load·

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

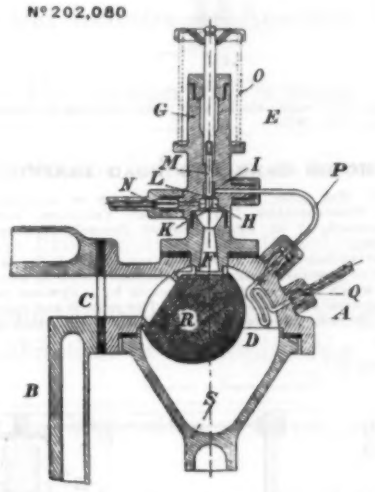
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

202,080. May 22nd, 1922.—FUEL INJECTORS, A. Bagnulo, Via Bogino 13, Turin, Italy.

The inventor proposes to improve the efficiency of oil engines by using as fuel a mixture of steam and oil, which is passed through a catalysing agent. The injecting and vaporising apparatus A is connected to the upper end of the cylinder B and comprises a combustion chamber D and an injector E. The injector E comprises the double-cone diffuser or sprayer F and the valve holder G, which is provided with two chambers H and I opening into the combustion chamber D and controlled by valves

N° 202,080

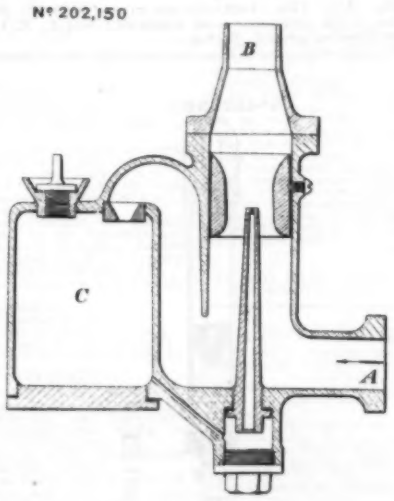


K and L respectively, having a single operating rod M and normally held on their seats by the spring O. Fuel is pumped from N to the chamber H and steam is delivered into the chamber I through the tube P, which passes through the combustion chamber D and is supplied with water by a pump through the tube Q, the water being converted into steam in its passage through the combustion chamber. Below the injector is situated a net R of nickel or other catalysing metal. The lower part of the combustion chamber D is heated at starting by means of a lamp.—*August 16th*, 1923.

202,150. July 25th, 1922.—STARTING DEVICES, F. Saintin, 6, Rue de Paris, Poissy, Seine-et-Oise, France.

The inventor proposes to start internal combustion engines by admitting compressed air to the cylinder, the air being carburetted immediately before admission. The crank shaft is held, in the meanwhile, either by a catch or, in the case

N° 202,150



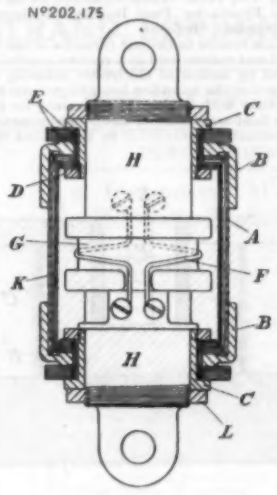
of multi-cylinder engines, by corresponding admission to another cylinder acting in opposition. The catch is then released and the charge exploded to start the engine. The drawing shows the carburetter. The compressed air is admitted at A, while the connection with the cylinder is shown at B. C is the fuel chamber.—*August 16th*, 1923.

SWITCHGEAR.

202,175. August 29th, 1922.—IMPROVEMENTS IN OR RELATING TO ELECTRIC FUSIBLE CUT-OUTS, Adolph Harry Railing, Charles Cornfield Garrard, and Arthur Frederick Searle, all of Magnet House, Kingsway, W.C. 2.

This invention relates to improvements in means of mounting electric fusible cut-outs in explosion-proof cases. The case A is preferably made of iron or other metal tube, preferably plain, as shown in the drawing, or in some cases screwed at each end. Flanged rings or centrally bored caps B, each provided with a metal flanged bush C, are securely clamped to the case by a screwed ring or nut D and insulated by mica or other insulation E. The end caps B B are provided with ample surface around the tube so as to form explosion-proof joints. If desired, the tube and caps may be screwed together or made with flanged parts for bolting together, and the tube A is preferably lined with asbestos or other insulating material K. The fuse wire F is mounted on a porcelain carrier G with terminals H. The lower

N°202,175



terminal H is clamped to its bush C by means of the screwed ring or nut L and the upper terminal slides through the top bush C. Thus the fuse carrier G is firmly attached to the lower end cap and is readily fixed into position in the tube A by screwing the nut or ring on to the upper terminal H, which slides through the bush C of the upper cap B.—*August 16th*, 1923.

TRANSFORMERS AND CONVERTERS.

202,036. May 11th, 1922.—IMPROVEMENTS IN ELECTRICAL TRANSFORMERS, The British Transformer Company, Limited, of Hayes, Middlesex, and Jan Rootham.

The object of this invention is to enable the leakage reactance of an electrical transformer to be reduced below that of the normal reactance without changing the relative positions of the windings or altering the construction of the transformer. In

N°202,036

the example shown A is the high-tension winding and B the low-tension winding of the transformer, having between them an air space C in which a number of separate copper tubes D are placed. By varying the number of these tubes or by varying the diameter and wall thickness of the tubes adjustment of the leakage reactance can be obtained within very close limits.—*August 13th*, 1923.

TELEGRAPHS AND TELEPHONES.

180,338. May 19th, 1922.—IMPROVEMENTS IN AND RELATING TO THE TRANSMISSION OF SOUND BY MEANS OF LIGHT WAVES, *The British Thomson-Houston Company, of Crown House, Aldwych, W.C. 2.*

According to this invention a beam of light is oscillated in accordance with the sound waves so as to vary the illumination of a photo-electric cell, the current variations produced thereby being amplified by coupling a cell by ohmic resistance to the grid circuit of a thermionic amplifier in the output circuit of

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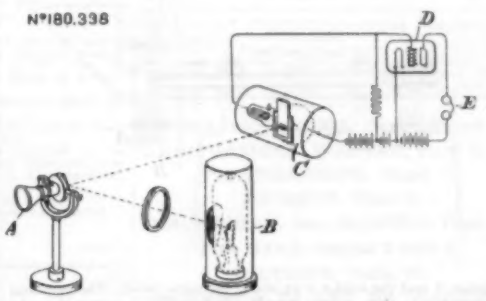


which a sound receiver is connected. A transmission line may be coupled by a transformer to the output circuit in place of the sound receiver, which is then connected across the remote end of the transmission line. A duplicate transmitting apparatus may be coupled to the transmission line when it is desired to transmit and receive from either end of the line, a sound receiver then being connected in shunt across the secondary of the first-named transformer. In the drawing A is the transmitter, B the source of light, C the photo-electric cell, D the amplifier, and E

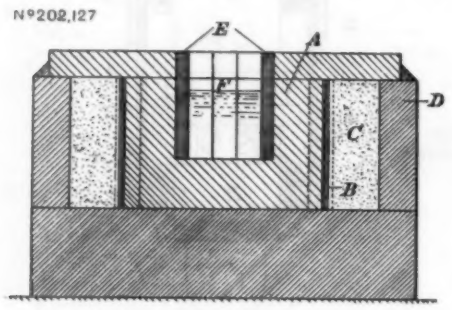
the telephone receiver. The details of the system are fully described, and there are three other illustrations.—*August 16th*, 1923.

FURNACES.

202,127. July 1st, 1922.—IMPROVEMENTS IN OR RELATING TO ELECTRIC FURNACES, Paul Richard Kuehnrich, of Holly Court, Eccleshall, Sheffield.

This invention relates to electric furnaces of the kind in which salts are fused and maintained in a molten condition by electric energy applied by means of electrodes entering the salt container, the object of the invention being to provide improvements in such a furnace with a view to increasing its efficiency and utility for the heat treatment of steel. The container A for the salts is substantially rectangular in shape and is built up of

Nº 202,127



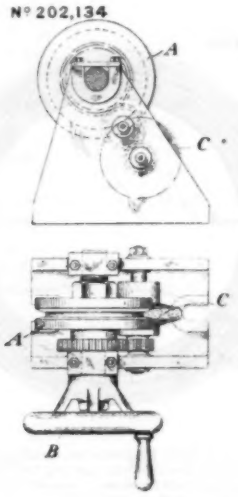
refractory material strengthened by a metal casing and angle irons B at the corners. It is surrounded by a layer C of heat-insulating material, such as kieselguhr, which is enclosed in a covering, preferably of brickwork D. The electrodes E are disposed at opposite sides of the container A. They are composed of an alloy of nickel, chromium, silicon, and aluminium which is substantially free from iron. The electrodes are connected up to a transformer or other suitable supply of electric energy through integral tail pieces. A recess F may be provided for a pyrometer. —*August 16th*, 1923.

CRUSHING AND GRINDING.

202,134. July 8th, 1922.—DRESSERS FOR ABRASIVE WHEELS, White and Poppe, Limited, Lockhurst-lane, Coventry, and J. S. Thompson, Narn, Holbrook-lane, Coventry.

This dresser is intended for shaped abrasive wheels and takes

Nº 202,134



the form of a roller A of the required contour, which is slowly rotated by the hand wheel B. A wire brush C is mounted behind the roller, with which it is geared as shown. This brush removes any particles which may adhere to the roller and prevents them from becoming embedded in its surface.—*August 16th*, 1923.

202,155. July 27th, 1922.—GRINDING MILLS, J. M. Fleming, Birch Hall-lane, Longsight, Manchester, and W. H. Barnes, Clifton-street, Levenshulme, Manchester.

In this machine the grinding is effected between the fixed plate A and rotary plate B. The feed is through the eye of the

Nº 202,155

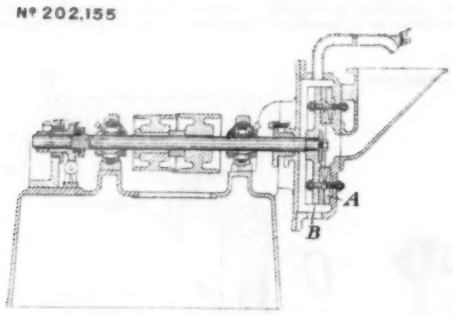


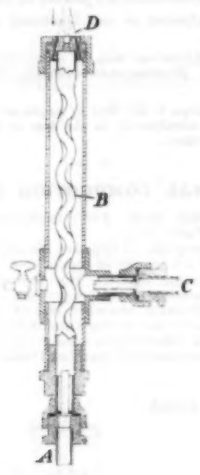
plate A and the outlet is at about the same level. The grinding chamber is thus always partly filled with the material to be ground, and the plates are so formed that they continuously lift it up from the bottom of the chamber and return it to the grinding zone.—*August 16th*, 1923.

LIGHTING AND HEATING.

202,136. July 12th, 1922.—OIL BURNER, R. Cooper, Cawthorne, Framlingham-road, Brooklands, Cheshire, and C. Champion, 3, Westbourne-road, Urmston, Manchester.

In this burner the oil is supplied at A and finds its way into the indented tube B. Steam is admitted to the jacket surrounding the tube B by the connection C and thus heats up the oil. The oil and steam emerge by the spraying jets D, which are so

Nº 202,136



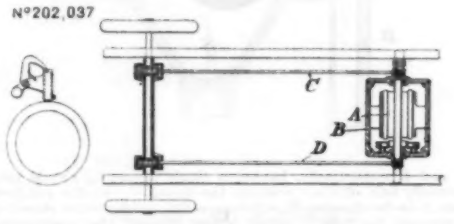
arranged as to make the oil and steam intermingle thoroughly. —*August 16th*, 1923.

MOTOR CARS AND ROAD TRAFFIC.

202,037. May 11th, 1922.—IMPROVEMENTS IN AND RELATING TO ELECTRICALLY DRIVEN ROAD VEHICLES, Frederick Crawford, of 35, Ellesmere-road, Benwell, Newcastle-on-Tyne.

The invention relates to power-driven road vehicles in which the motive power is transmitted to the road wheels by an electric motor, which is driven by batteries or by a dynamo coupled to an internal combustion engine. The rotor A and carcase or field B are rotatably mounted so that they will rotate in rela-

Nº 202,037



tively opposite directions, and the drive of one of these members is transmitted to one of the road wheels and the drive of the other to the other road wheel through separate driving gears, similarity of direction of rotation of the road wheels being provided for. The motor is mounted on a transverse axis parallel with that of the pair of driven road wheels, and the drive is taken through two longitudinal shafts C and D each provided with two worm gears. The inclination of one of the worm for one wheel is reversed relatively to that for the other wheel.—*August 13th*, 1923.

MISCELLANEOUS.

202,156. July 27th, 1922.—LUBRICATING DEVICES, H. D. Henry, 22, Grosvenor-road, Chiswick; and L. E. Little, 30, Ederline-avenue, Norbury.

The inventors propose to force grease or other heavy lubricants

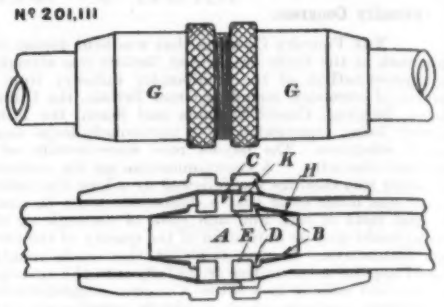
Nº 202,156

into bearings by means of gaseous pressure and evidently contemplate the use of Sparklets for providing the pressure gas. A piston is provided between the gas and the lubricant.—*August 16th*, 1923.

201,111. March 3rd, 1923.—IMPROVEMENTS IN PIPE CONNECTIONS, Bert Ernest Law, of 76, East Dulwich-grove, S.E. 22.

In the drawing A is a hollow ferrule of brass or other metal, and it is provided with tapered ends B and a centrally disposed collar or shoulder C. At a convenient distance from the thin taper ends B there are shoulders or seating cutters D, which, in conjunction with the centrally disposed shoulder or collar C, form housings E for the reception of rubber packing rings K. The usual internally flared coupling members, which are adapted to be screwed together, are shown at G. In use, the coupling members G are placed over their respective pipes and the ends of the pipes are flared or formed with a belled mouth H. The ferrule A is then inserted into the flared mouths H of the pipes and the coupling members G are screwed together, drawing the

Nº 201,111



ends of the pipes tightly against the packing rings, whilst the shoulders or cutters D cut their own seatings into the pipes, thus making two perfect joints at each end of the ferrule A.—*July 26th*, 1923.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

MONDAY, SEPTEMBER 17TH, TO WEDNESDAY, OCTOBER 3RD.

National Gas Exhibition at Bingley Hall, Birmingham.

SATURDAY, SEPTEMBER 22ND.

MANCHESTER ASSOCIATION OF ENGINEERS.—Student members' visit to the works of the Metropolitan-Vickers Electrical Company, Limited, Trafford Park. 3 p.m.

THURSDAY, SEPTEMBER 27TH.

MANCHESTER ASSOCIATION OF ENGINEERS.—Members' visit to the Penistone Works of Cammell Laird and Co., Limited. Leave Manchester (London-road) 12.40 p.m.

MONDAY, OCTOBER 1ST.

INSTITUTE OF TRANSPORT.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. Presidential address by Sir J. G. Broodbank. 5.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WE are informed that the whole of the shares in the foundry and engineering business of Herring and Son, Limited, of Chertsey, have been purchased by Mr. Trewhella, of Belsize-lane, London, N.W.

ALFRED HERBERT, Limited, Coventry, are very pleased to be able to state that they have received a cable from the manager of their Japanese branch to the effect that all the staff and their families are safe. There is no further news to hand at present.

WE are informed that Rear-Admiral Sir Godfrey M. Paine, K.C.B., M.V.O., who was the Fifth Sea Lord of the Admiralty and Air Vice-Marshal during the war, has been elected chairman of the Wellman Smith Owen Engineering Corporation, Limited, of London and Darlaston.

THE NATIONAL GAS ENGINE COMPANY, Limited, asks us to say that it will be pleased, during the coming winter, to assist lecturers upon the subject of internal combustion engines and/or suction gas plants by lending them lantern slides free of charge. A descriptive list of slides will be forwarded on request.

SIR CHARLES BRIGHT informs us that he has withdrawn from the board of Sir Charles Bright and Partners, Limited. The company is at present retaining his name in its title, but Sir Charles himself is no longer associated with its activities and, temporarily, his only business address is 25, Victoria-street, Westminster. Telephone number, 650 Victoria.

WE are informed that Mr. C. P. Newman has purchased the Woodchester Works of the United Brassfounders and Engineers, Limited, as a going concern from the receiver of that company, and has re-registered the name of Newman, Hender and Co., Limited, whose business was absorbed by the United Brassfounders and Engineers, Limited, in 1910, and which now resumes its independent identity. The intention of the new company is to manufacture a complete line of valves, cocks and general steam and water fittings, such as have been made at the various works of United Brassfounders and Engineers, Limited, but at the one point—Woodchester—where will be located the complete manufacturing and commercial organisation.

CONTRACTS.

THE UNDERFEED STOKER COMPANY, Limited, of Aldwych House, Aldwych, London, W.C. 2, has recently received orders for seventy-five travelling grate stokers, thirty-one Underfeed stokers, two air heaters, four ash conveyors, four arches, and one coal conveyor.

WILLIAM BEARDMORE AND CO., Limited, whose locomotive works at Dalmuir have quite a fair amount of work in hand for the Burma Railway and Indian State Railways have recently booked another order for the North-Western Railway of the latter system. This is for five standard passenger superheated 4–6–0 type engines and six-wheel tenders, similar to the thirty already in hand for the Indian State Railways. These locomotives weigh over 120 tons in working order.

INSTITUTION OF ELECTRICAL ENGINEERS.—The opening meeting of the session of the Institution of Electrical Engineers will take place on Thursday, October 18th, when Dr. Alexander Russell, M.A., D.Sc., will deliver his inaugural address as President. The premiums awarded for last session's paper will be presented on this occasion.